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MAMMAL SURVEY

OF

Northwestern Pennsylvania



FINAL REPORT

PITTMAN-ROBERTSON PROJECT 20-R

COMMONWEALTH OF PENNSYLVANIA



JAMES H. DUFF, *Governor*



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MAMMAL SURVEY OF NORTHWESTERN PENNSYLVANIA

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PUBLISHED BY
PENNSYLVANIA GAME COMMISSION
AND
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1949

INTRODUCTION

This survey of the mammals of northwestern Pennsylvania is part of a larger program undertaken to obtain practical management information about the mammals of Pennsylvania with particular reference to life history, ecology, species range, abundance, habitat preference, effects of land use on populations, and economic importance of the animals occurring there.

To achieve these objectives it was proposed to institute field studies in six natural geographical sections of the Commonwealth. Because of the manpower shortage in 1946 when this Project was undertaken, and because of the necessity of working out techniques in detail, it was felt desirable to limit the survey at that time to one section. The northwestern portion of the state was chosen as the initial work area since this section of Pennsylvania is one of the most varied, both in its topography and in its land use.

Although this report is based primarily upon the field notes of the Project Leader and Assistant Project Leaders, everyone associated with the Project has contributed much in the way of information and suggestions. However, the responsibility for the information included here, and the interpretations given it, are those of the writers, Neil D. Richmond, Project Leader, and Harry R. Roslund, Assistant Project Leader.

ACKNOWLEDGMENTS

The Survey of Pennsylvania Mammals, Pittman Robertson Project 20-R, was conducted under the Federal Aid to Wildlife Restoration Act of 1937, and was supervised jointly by the Pennsylvania Game Commission and the United States Fish and Wildlife Service.

The Project was under the immediate direction of the Wildlife Research Division, Pennsylvania Game Commission, and was directed by Mr. Robert D. McDowell, Chief of the Division.

Dr. J. K. Doult, Curator of the Section of Mammals, Carnegie Museum, Pittsburgh, Pa., as Supervisor of Special Personnel was responsible for the planning and supervision of the field work and for the taxonomic studies involved.

Miss Caroline Heppenstall, Assistant Curator of Mammals, aided in the identification of the specimens, and was responsible for the many details involved in receiving, handling, and caring for the collection of mammals and data as they were sent in from the field.

The field work was done by the Project Leader and one Assistant Project Leader. The following served as Assistant Project Leaders during the course of the Project:

John J. Christian July 1946 to May 1947
Clay L. Gifford May 1947 to October 1947
Woodrow W. Goodpaster .. October 1947 to March 1948
Harry R. Roslund March 1948 to November 1948

The following Part-Time Assistants have worked for various lengths of time on the preparation of the skeletal material, food habit studies, and typing: John E. Guilday, LaVerne D. Mowry, A. C. Lloyd, Walter Bleckman and A. D. Lewis.

To all who were directly associated with the Project we wish to express our appreciation. In addition, we thank the following organizations and individuals:

The Pennsylvania Department of Internal Affairs, Topographic and Geologic Survey for permission to use their map showing the physiographic divisions of Pennsylvania.

The United States Department of Interior, Fish and Wildlife Service; the United States Department of Agriculture; the United States Soil Conservation Service; Pennsylvania State Department of Agriculture, the Laboratory Division, Bureau of Animal Industry; the United States Department of Interior, Geological Survey, for their services and publications.

Dr. P. F. English, Dr. Logan J. Bennett and Dr. Ward M. Sharp of the Pennsylvania Cooperative Wildlife Research Unit, The Pennsylvania State College, for suggestions and reprints.

The members of the various sections of Botany and Zoology in Carnegie Museum, Pittsburgh, for their cooperation in helping us to identify the various fragmentary plant and animal remains for our food studies.

Mr. Hayes T. Englert, Division Supervisor, and the District Game Protectors of Division F, Pennsylvania Game Commission, for their interest and cooperation in saving specimens and for helping us to find housing throughout the area.

The many trappers, furbuyers, sportsmen and landowners, for their information, specimens and general interest.

We not only appreciate the assistance and cooperation we have received in our work in northwestern Pennsylvania, but we like to believe that we have met several good friends in the course of the past two years.

TABLE OF CONTENTS

	Page
INTRODUCTION	2
ACKNOWLEDGMENTS	2
HISTORY	6
AREA	6
PHYSIOGRAPHY	7
CLIMATE	8
DRAINAGE	8
MAN'S INFLUENCE	8
METHODS AND PROCEDURES	10
MAMMALIAN HABITATS IN NORTHWESTERN PENNSYLVANIA	13
DISCUSSION BY SPECIES	14
GAME AND FURBEARERS	15
White-tailed Deer (<i>Odocoileus virginianus borealis</i>)	16
Elk (<i>Cervus canadensis canadensis</i>)	16
Black Bear (<i>Ursus americanus americanus</i>)	17
Snowshoe Hare (<i>Lepus americanus virginianus</i>)	17
Cottontail Rabbit (<i>Sylvilagus floridanus meamrsii</i>)	18
Gray Squirrel (<i>Sciurus carolinensis leucotis</i>)	21
Fox Squirrel (<i>Sciurus niger rufiventer</i>)	22
Red Squirrel (<i>Tamiasciurus hudsonicus loquax</i>)	23
Woodchuck or Groundhog (<i>Marmota monax monax</i>)	24
Raccoon (<i>Procyon lotor lotor</i>)	24
Opossum (<i>Didelphis virginiana virginiana</i>)	25
Beaver (<i>Castor canadensis canadensis</i>)	25
Muskrat (<i>Ondatra zibethica zibethica</i>)	26
Skunk (<i>Meplitis meplitis nigra</i>)	27
Mink (<i>Mustela vison mink</i>)	28
Least Weasel (<i>Mustela rixosa allegheniensis</i>)	29
New York Weasel or Common Weasel (<i>Mustela frenata noveboracensis</i>)	30
Bonaparte Weasel (<i>Mustela erminea cicognanii</i>)	31
Foxes (<i>Vulpes fulva fulva</i>) (<i>Urocyon cinereoargenteus cinereoargenteus</i>)	31

Dogs, Coyotes and Wolves (<i>Canis latrans latrans</i>) (<i>Canis lupus lycaon</i>)	34
INSECTIVORES	34
Hairy-tailed Mole (<i>Parascalops breweri</i>)	31
Star-nosed Mole (<i>Condylura cristata</i>)	36
Masked Shrew (<i>Sorex cinereus cinereus</i>)	37
Big-tailed Shrew (<i>Sorex dispar</i>)	38
Smoky Shrew (<i>Sorex fumeus fumeus</i>)	38
Least Shrew (<i>Cryptotis parva parva</i>)	39
Short-tailed Shrew (<i>Blarina brevicauda brevicauda</i>)	39
BATS	41
NON-GAME RODENTS	42
Thirteen-lined Ground Squirrel or Gopher (<i>Citellus tridecemlineatus tridecemlineatus</i>)	42
Chipmunk (<i>Tamias striatus</i>)	43
Flying Squirrel (<i>Glaucomys volans volans</i>)	44
Deer Mouse or White-footed Mouse (<i>Peromyscus leucopus noveboracensis</i>)	45
Cloudland Deer Mouse (<i>Peromyscus maniculatus nubiterrae</i>)	46
Prairie Deer Mouse (<i>Peromyscus maniculatus bairdii</i>)	46
Cliff Rat (<i>Neotoma magister</i>)	47
MICROTINE RODENTS OR VOLES	48
Lemming Mouse (<i>Synaptomys cooperi stonei</i>)	49
Red-backed Mouse (<i>Clethrionomys gapperi paludicola</i>)	50
Meadow Mouse (<i>Microtus pennsylvanicus pennsylvanicus</i>)	51
Pine Mouse (<i>Pitymys pinetorum scalopsoides</i>)	53
House Mouse (<i>Mus musculus musculus</i>)	54
Norway Rat (<i>Rattus norvegicus</i>)	55
Meadow Jumping Mouse (<i>Zapus hudsonius hudsonius</i>)	55
Woodland Jumping Mouse (<i>Napaeozapus insignis insignis</i>)	56
Porcupine (<i>Erethizon dorsatum dorsatum</i>)	56
CHANGES IN MAMMAL POPULATIONS	57
ECTOPARASITES	59
OWL PELLETS	61
CHECK LIST OF THE MAMMALS OF NORTHWESTERN PENNSYLVANIA	63
CONCLUSIONS AND RECOMMENDATIONS	65
DATA AND REPORTS	66
BIBLIOGRAPHY	67

HISTORY

The only previous comprehensive work on the mammals of Pennsylvania was done by Samuel N. Rhoads in his *Mammals of Pennsylvania and New Jersey* which was published in 1903. This work was completed at the turn of the century when Pennsylvania's wildlife resources were at their lowest ebb. At that time the bison, marten, wolverine, fisher, wolf, panther, elk, beaver and Canada lynx, all animals once native to this state, were extinct, and the deer, although not extinct, was rapidly becoming so. The extensive forests had been cut, and forest fires were common. This was the end of a period of plenty.

The next twenty years saw the slow development of organizations staffed and equipped to protect the remaining wildlife resources. The early efforts of game and forest managers were directed toward protection, restocking and replanting. Their efforts were rewarded, for once more Pennsylvania is noted for its excellent big and small game hunting. Eight hundred thousand hunting licenses and a fur crop worth half a million dollars annually testify to the importance of wildlife to Pennsylvanians.

In the last twenty years a new problem has arisen. Although there has been a spectacular increase in numbers of game animals since 1900, there has been a tremendous increase in the number of hunters. Today protection and restocking alone are not enough. Rather, in order to meet an ever increasing demand on our game animals, it is imperative that our wildlife areas be maintained at their maximum productivity. Out of this need has grown the concept and practice of managing wildlife.

To manage any living thing to the extent that its numbers can be increased or decreased at will requires a thorough knowledge of its requirements for living. To manage an area with its complex association of plants and animals requires a thorough knowledge of the important interrelationships of the plants and animals within that area.

To that end, by assembling the existing data of Pennsylvania mammals, and by supplying the necessary field investigations where present knowledge is insufficient, it is hoped that this study will present, in usable form, information that will assist the Pennsylvania Game Commission to manage efficiently the wildlife resources of the Commonwealth.

AREA

The area included in this survey is that part of Pennsylvania north of the Ohio River; from the Ohio State line, east to the eastern boundary of McKean, Elk, Jefferson and Armstrong Counties. It covers an area of approximately 9500 square miles, and includes all of Armstrong, Butler, Clarion, Crawford, Elk, Erie, Forest, Jefferson, Lawrence, Mercer McKean, Venango and Warren Counties as well as the northern half of Beaver County. (See map 4). This area has a relief of more than 1600

feet. The altitudes range from 573 feet in Erie County along the shore of Lake Erie, and 680 feet in Beaver County along the Ohio River to heights of 2200 feet in Jefferson and McKean Counties.

PHYSIOGRAPHY

The three major physiographic divisions of the area are: (Map 1) the unglaciated Allegheny Plateau, the glaciated Allegheny Plateau, and the Lake Plain in Erie County. (Leverett 1934, Leggett 1936, Fenneman 1938).

The unglaciated plateau is represented in this area by two sections: the Allegheny High Plateaus and the Pittsburgh Section. The high plateaus section is typified by the area most Pennsylvania hunters know as "The Big Woods" of Elk, Forest, McKean and Potter Counties. Much of this section is too severe in climate and too rough in terrain to be farmed extensively and remains as one of the large forested areas of the state. (Map 2).

In northwestern Pennsylvania the following animals are at present restricted to this high plateau: black bear, wildcat, elk, northern flying squirrel, porcupine, snowshoe hare, and with a few exceptions, Bonaparte weasel and the red-backed mouse. This is not to imply that any of these animals are restricted by the physiography of their environment, rather the physiography of the section has restricted man's utilization of the area, and although greatly changed by lumbering, this section remains more nearly in its original condition of vast forests than do the surrounding areas.

The glaciated plateau offers a decided contrast as the leveling effect of glaciation and the deposition of glacial till left an area that is generally suited to agriculture. As a result, most of this section shows evidences of having been cleared and farmed at some time in its history. Today these are the agricultural counties of northwestern Pennsylvania (Map 3). One of the characteristic features of the glaciated section are the numerous small swales, swamps and swampy valleys. These are too wet to farm, and many are so located as to be difficult to drain so they remain as small islands of thicket or woods dotted all over an area that is intensively farmed. As a result these counties produce the bulk of the muskrats, raccoon and mink taken in this section and offer the best small game hunting in northwestern Pennsylvania.

The lake plain forms a narrow strip around the shore of Lake Erie varying from less than a mile in width at the New York State line to almost 10 miles at the Ohio state line. This section, like the glaciated section, is well suited to farming. Since its climate,⁹ as modified by the presence of the lake, is especially suited to the growing of peaches, grapes and other fruits, it is intensively utilized for vineyard, orchards and truck farming.

The Pittsburgh section of the unglaciated plateau has more gentle slopes and better soils than the high plateau section to the north of it, and is more intensively farmed. In this respect, it is intermediate between the glaciated section to the west of it, and the high plateau to the north.

CLIMATE

The climate of northwestern Pennsylvania is relatively uniform. Although the difference is not great, there is a gradient from northeast to southwest. The counties of Warren, McKean and Elk are both the coolest and the wettest; Beaver is the warmest and driest. The climate of the lake plain in Erie County is distinctive in having the longest frost-free period.

The average annual precipitation varies from 36" in western Mercer County to 46" in northeastern Warren County. Most of the area receives 40-42" annually and the average growing season varies from 193 days at Erie on the lake plain to 113 days at Brookville in Jefferson County. Both the annual precipitation and the length of the growing season are subject to great deviation from the average in any one year. For example, at the Meadville station, according to the U. S. Weather Bureau records, the length of the growing season (that is, the number of days without killing frost) was 179 in 1946 and 119 in 1945.

DRAINAGE

Except for the relatively narrow lake plain all of northwest Pennsylvania is drained by the tributaries of the Ohio River; most of it by the Allegheny and its tributaries (Map 4). The streams have moderate to steep gradients and, for the most part, drain areas that are steep and have a rapid runoff of rainfall. As a result, any deviation from the usual monthly rainfall of approximately 3" produces either floods, or very low stream levels.

MAN'S INFLUENCE

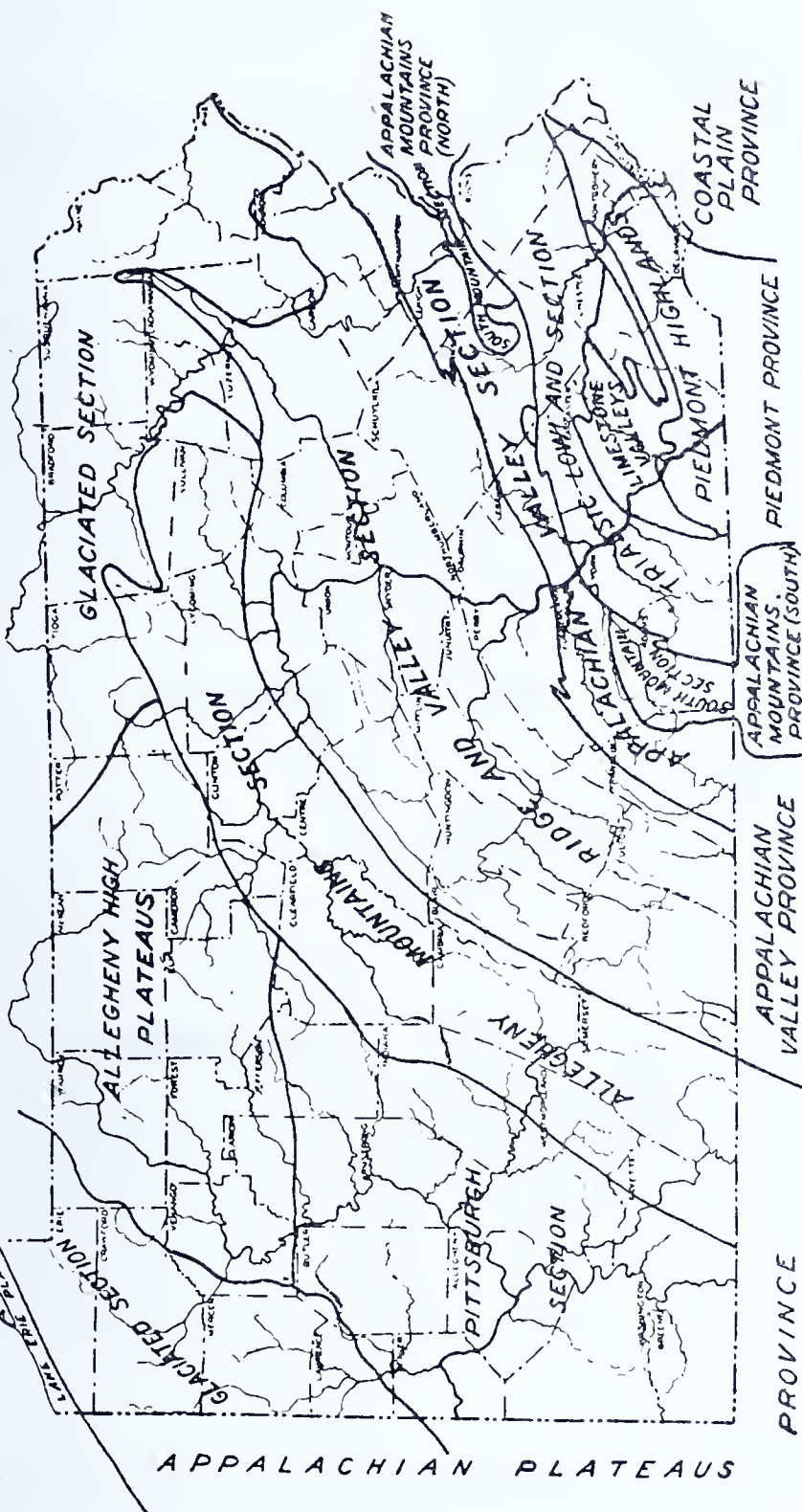
In addition to the factors of climate and physiography, the present day distribution of some of our mammals is the result of man's activities. Man's direct influences are apparent when animals are exterminated or when they are introduced and protected, and his indirect effect is seen when he so changes the environment that the original inhabitants are displaced and other species move in.

The beaver is an example of man's direct influence. It was first exterminated throughout this area, and then later reintroduced and protected until it once again occurs over much of its former range.

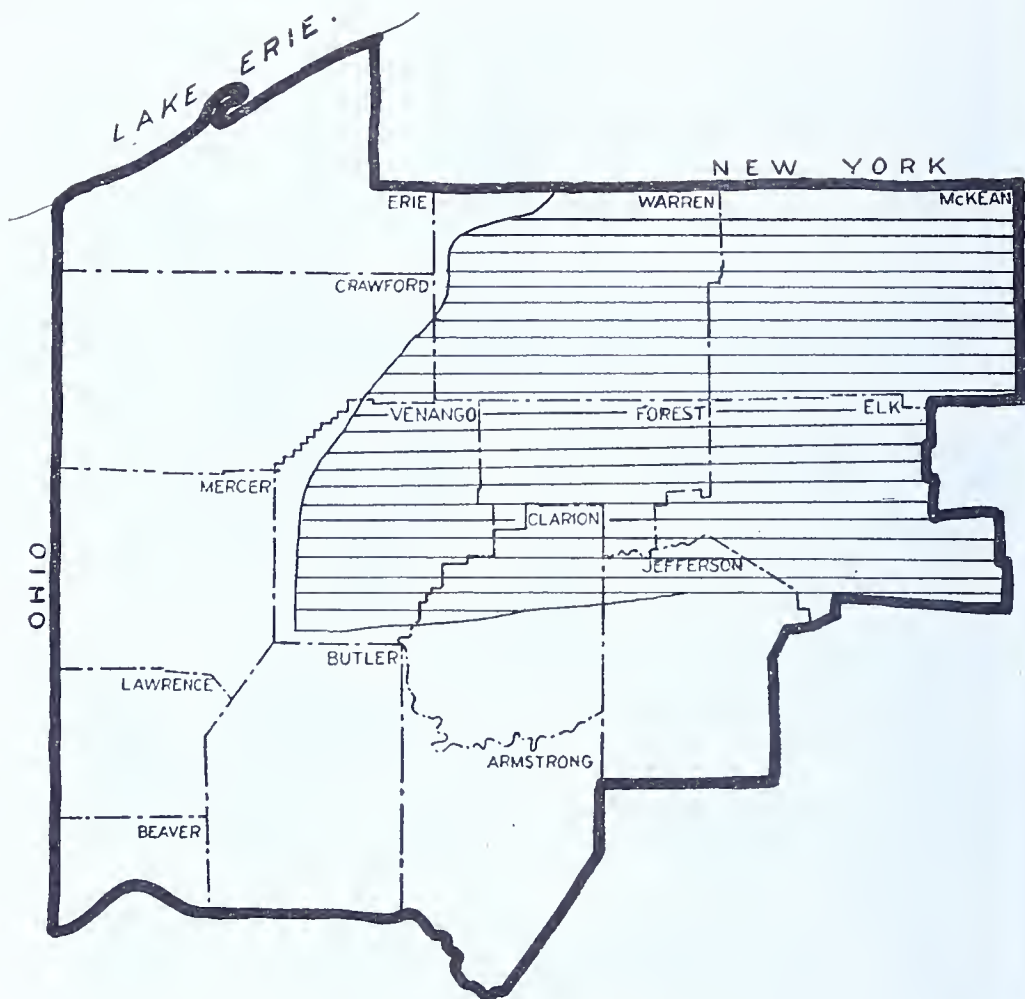
Even greater displacements have resulted from man's clearing the forests for agriculture. This has reduced the range of many forest animals at the same time that it has expanded the range of animals that live in grass lands or brushy areas. Associated with these changes is the important factor of the tolerance of each species to change, and to disturbance. Some species, rats and foxes for example, can increase both their range and their numbers in direct opposition to "civilization" but others less able to adjust, disappear as have the wolves, bison and elk as the country becomes settled.

CENTRAL LOWLAND
PROVINCE
EASTERN LAKE SECTION

APPALACHIAN PLATEAUS PROVINCE



MAP 1. PHYSIOGRAPHIC DIVISIONS OF PENNSYLVANIA



MAP 2. THE HIGH PLATEAUS SECTION OF NORTHWESTERN PENNSYLVANIA

METHODS AND PROCEDURES

The field work for this area was initiated in July 1946 and was completed in October 1948. The results of our work in the field are presented here in considerable detail. When the data for the entire state is collected and correlated, the value of this and similar reports will be in their original data. As a result, the treatment of the various species is not uniform, but varies with the amount and kind of information obtained during this study for that species. There is included a report on all specimens and materials collected, what of these are at present being studied, and those for which there is as yet no report.

Ten areas which represent one or more of the major ecological subdivisions of the northwestern sixth of Pennsylvania were chosen for intensive study (Map 5). An effort was made to obtain information and specimens of each species in every major habitat within these selected areas. Special effort was made to study any isolated habitats in the area.

These selected localities were trapped intensively and representative series of the species taken were prepared as study skins using standard procedures. Where apparent correlations existed, they were checked by trapping or examining other similar localities to determine the validity of the correlation.

During the winter months, trappers and fur-buyers were interviewed and their catches examined. A particular effort was made to obtain information concerning the winter food habits, habitat preferences, abundance, diseases and parasites of the fur-bearers of the section.

All evidences of predation were noted and combined with analysis of scats, stomach contents and owl pellets. Observations of food habits were recorded, noting in particular competition between species for food and any evidences of preferred foods or available foods that were ignored. Considerable miscellaneous life history data was observed and recorded in the daily notes and photographs.

The original data, including 953 pages of field notes, 500 photographs, and 4675 specimens (exclusive of parasites) collected in these selected study areas and elsewhere in northwestern Pennsylvania during the 28 months of this project have been deposited in the section of Mammals, Carnegie Museum, Pittsburgh, Pennsylvania.

Following is a table showing the localities studied:

LOCALITIES TRAPPED

BUTLER COUNTY

<i>No.</i>	<i>Dates Trapped</i>
1. 2 mi. E. Mars	July 15–September 15, 1946
2. 3 mi. E. Mars	July 25–July 30, 1946
4. 4 mi. S. Butler	August 14–August 19, 1946
5. 2 mi. W. Saxonburg	August 20–September 2, 1946
7. 2 mi. E. Middle Lancaster	September 5–September 8, 1946

BEAVER COUNTY

8. 1 mi. NE. Darlington	September 15–December 1, 1946
9. ½ mi. N. Ohioville	September 3–October 12, 1946
10. 1 mi. S. Rowtown	October 15–October 21, 1946
11. ½ mi. N. New Galilee	October 21–October 29, 1946
12. 4 mi. W. Darlington	October 23–October 26, 1946
13. ½ mi. NW. New Galilee	October 31–November 3, 1946
16. 2 mi. N. Industry	May 12–May 24, 1947

LAWRENCE COUNTY

14. 1 mi. S. McConnell's Mills	November 11–November 19, 1946
15. ½ mi. N. McConnell's Mills	November 20–November 23, 1946
28. 4 mi. SW. New Wilmington	July 16–July 19, 1947

VENANGO COUNTY

17. 3 mi. NW. Franklin	January 24–January 31, 1947
18. 6 mi. E. Oil City	February 7–March 23, 1947
Retrapped	February 24–March 4, 1948

<i>No.</i>		<i>Dates Trapped</i>
19.	2 mi. S. Franklin	March 24—April 16, 1947
	Retrapped	December 16—December 21, 1947
20.	2 mi. NE. Franklin	March 31—April 8, 1947
21.	2 mi. E. Franklin	April 3—April 30, 1947
22.	4 mi. S. Franklin	April 17—April 30, 1947
23.	9 mi. E. Oil City	April 30—May 5, 1947
24.	1 mi. SW. President	April 30—May 5, 1947
42.	2 mi. W. Polk	January 7—February 20, 1948
44.	4 mi. W. Franklin	January 18—February 10, 1948
46.	6 mi. N. Oil City	March 5—March 25, 1948
47.	1 mi. NE. Kennerdell	March 23—April 4, 1948
49.	1 mi. SW. Utica	April 10—April 13, 1948
	Retrapped	September 1—September 4, 1948

MERCER COUNTY

43.	3 mi. E. Sandy Lake	January 9—January 18, 1948
25.	2½ mi. W. Mercer	June 1—July 27, 1947
26.	5 mi. S. Mercer	July 9—July 23, 1947
27.	12 mi. W. Mercer	July 12—July 16, 1947
29.	2 mi. N. Clarks Mills	July 23—July 27, 1947

WARREN COUNTY

30.	½ mi. N. Pittsfield	August 10—October 18, 1947
31.	5 mi. E. Columbus	August 11—August 22, 1947
32.	4 mi. SW. Youngsville	September 8—September 12, 1948
33.	1 mi. SE. Garland	September 13—September 18, 1947
34.	5 mi. NW. Pittsfield	September 18—September 24, 1947
35.	1½ mi. N. Pittsfield	September 22—October 4, 1947
36.	2 mi. N. Pittsfield	October 3—October 7, 1947
37.	6 mi. N. Pittsfield	October 11—October 14, 1947
56.	2½ mi. N. Kinzua	June 14—August 2, 1948

ERIE COUNTY

38.	8 mi. NW. Corry	October 14—October 18, 1947
39.	East Springfield	October 24—November 15, 1947
40.	3 mi. N. West Springfield	November 19—November 21, 1947
41.	4 mi. W. East Springfield	November 19—November 21, 1947
59.	2 mi. N. North East	September 8—September 16, 1948
60.	4 mi. SW. North East	September 10—September 29, 1948

JEFFERSON COUNTY

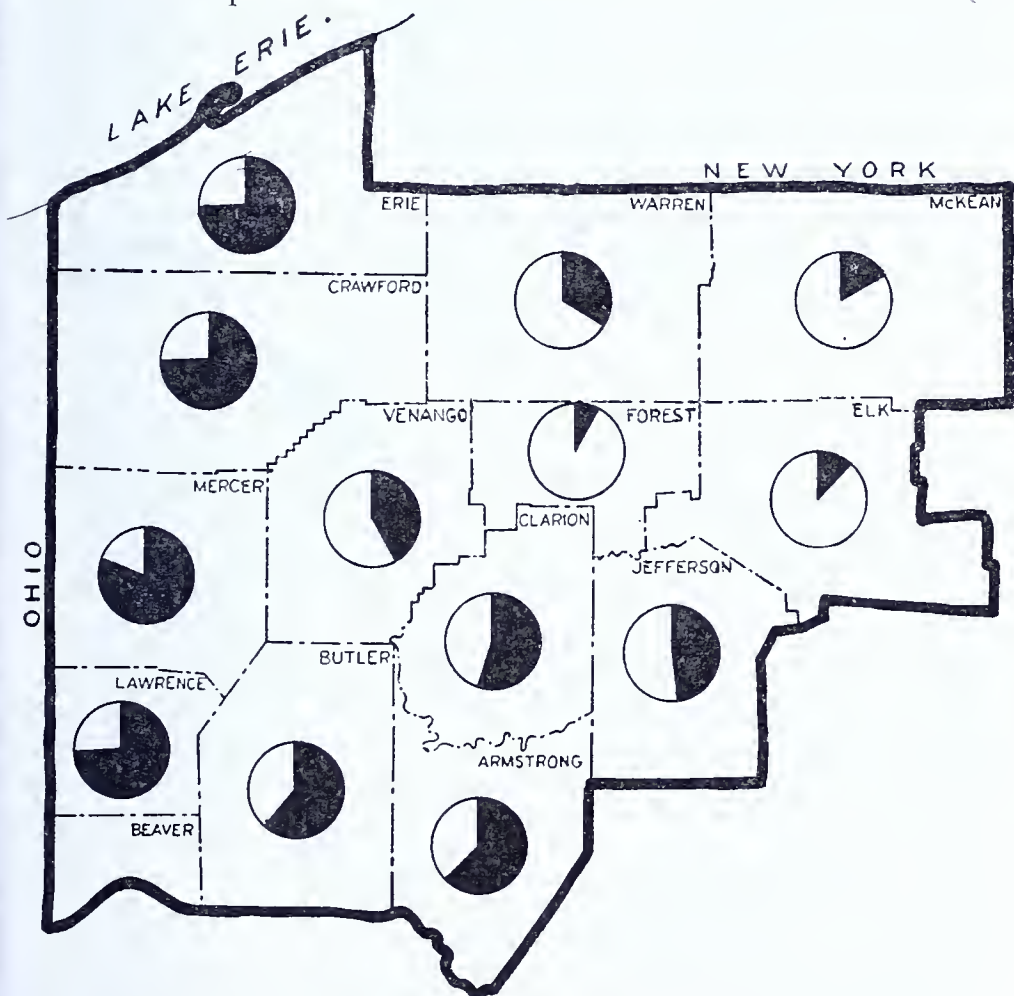
50.	5½ mi. NE. Sigel	April 14—June 13, 1948
51.	8 mi. NE. Sigel	May 10—May 19, 1948
52.	6 mi. E. Sigel	May 19—May 22, 1948
54.	5 mi. E. Sigel	May 24—May 26, 1948

McKEAN COUNTY

55.	10 mi. SW. Bradford	June 20—June 29, 1948
57.	4 mi. NE. Clermont	August 6—August 24, 1948
58.	4 mi. N. Clermont	August 11—August 15, 1948

MAMMALIAN HABITATS IN NORTHWEST PENNSYLVANIA

Forest, field, and water edge comprise three distinct mammalian habitats in northwest Pennsylvania. The most important of these from the standpoint of original area and number of native species is the forest which is here construed as any continuous area in which the ground is substantially shielded from the direct rays of the sun by woody plants during the growing season. Differences in the size, number, species, and condition of the plants, water conditions, exposure, soil, and character of underlying and exposed rocks may produce niches especially favorable or unfavorable for a particular species. *Neotoma magister*, for instance, is apparently restricted in this area to outcrops of massive sandstones and the dry rock slopes below such exposures, while *Sorex dispar* is usually found in rock accumulations which provide bare rock surfaces roofed over by leaf mold, mosses ferns, or more stone. Dense undergrowth is necessary for a high population of varying hares, and dense top growth, whether evergreen or deciduous, is likely to be reflected in a high population of red squirrels.



MAP 3. DISTRIBUTION OF FARMING IN NORTHWESTERN PENNSYLVANIA. BLACK PORTION INDICATES PERCENTAGE OF COUNTY IN FARM LAND

A ground cover of shade intolerant plants produces the habitat in which are found *Microtus*, *Synaptomys*, *Cryptotis*, *Zapus* and *Peromyscus maniculatus bairdi*. The last of these field forms is probably a recent immigrant from the prairie, and another midwestern mammal, *Citellus*, has been introduced in the vicinity of Polk where it occupies warm, dry, grassy situations. As in the case of the forest, local variations in plant cover and substratum influence the mammal population of fields.

A relatively permanent relationship between water surface and land surface is essential to the existence of the beaver, muskrat, and the otter. In addition, the beaver is dependent upon the presence of suitable tree species near the water and the muskrat on the presence of herbaceous plants in or near the water.

A large number of Pennsylvania mammals are tolerant of such a wide range of conditions that it is inadvisable to ascribe any one habitat to any of these species. Outstanding among this group is *Blarina* which may be taken in any terrestrial situation at any time. *Condylura* can be expected to occur wherever soil moisture is high, *Parascalops* where the soil is not saturated with water, and the woodchuck where an underground den exists or can be dug by it, to mention only a few. In general, it is the availability of food that determines the population densities . . . but not the distribution . . . of such species within our area.

Where forest and field merge, their characteristic inhabitants mingle in varying degree and such forms as woodchucks, rabbits, skunks, opossums, foxes, weasels, chipmunks and *Peromyscus leucopus* reach their greatest densities. *Clethrionomys* and *Pitymys* venture out into the fields and squirrels into open groves or fencerows while *Microtus* and *Zapus* penetrate the shaded woodland. The advance is seldom extensive and never permanent, but it does result in a cover type that is richer in number of species than either forest or field alone.

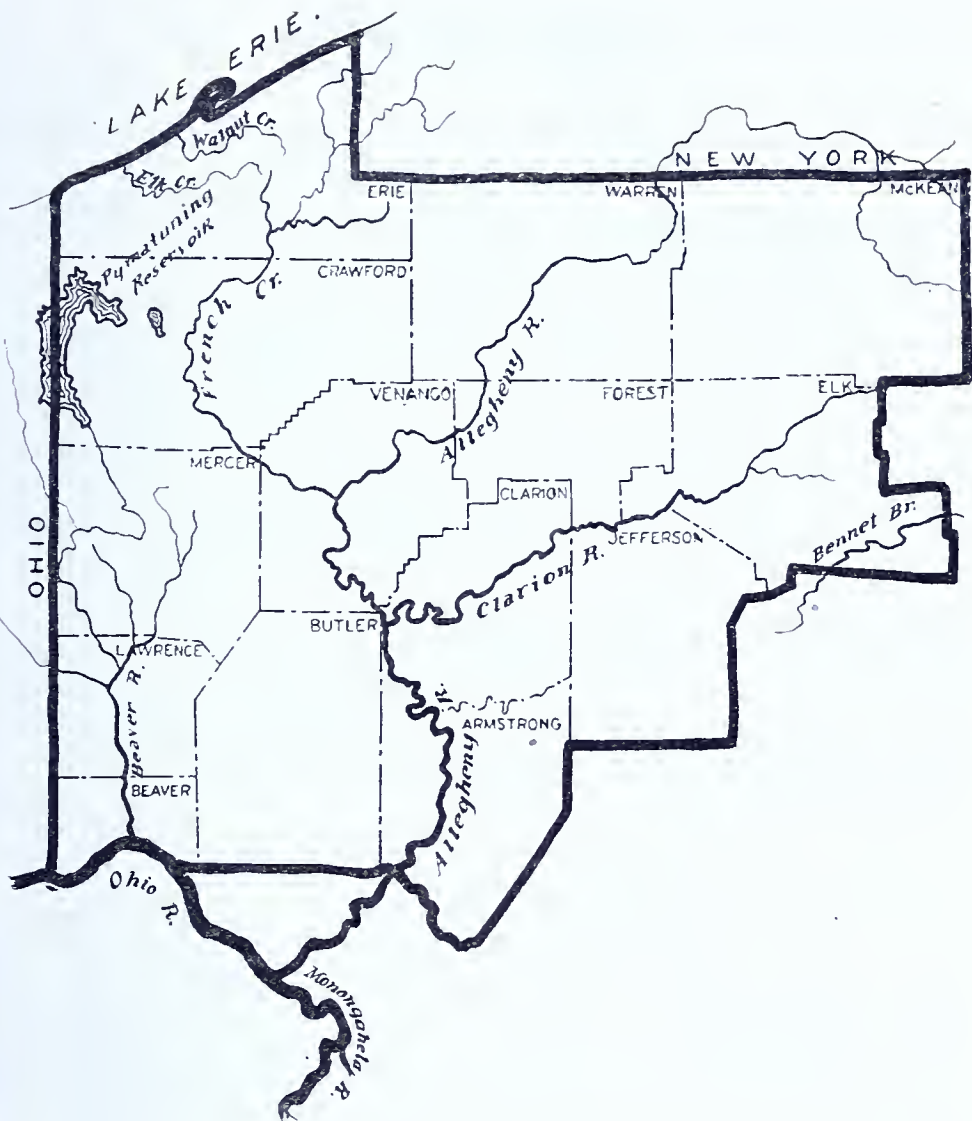
DISCUSSION BY SPECIES

The various species of mammals occurring in northwestern Pennsylvania have been grouped under the headings GAME AND FURBEARERS, INSECTIVORES, BATS and NON-GAME RODENTS.

To obtain information on the size and frequency of litters as well as on the length of the breeding season, all specimens were examined and the number and size of embryos noted.

In the absence of embryos, the pigment spots that are left on the uterus at the sites of implantation were counted. These spots have been commonly referred to as "placental scars." When present, they are evidence that the specimen is sexually mature and are a record of the number of young in the litter. It is thought that those fetuses that die and are resorbed also leave scars. This would mean that in a long series of data the average number of scars would be higher than the average number of young born. In our work no effort was made to count more than the most recent series of scars as we found that in the small rodents only the most recent were clearly distinct.

This information is presented in tabular form in the species discussions. The number of scars given in the table represents the number of young in the last litter, including those that were resorbed.



MAP 4. DRAINAGE SYSTEMS OF NORTHWESTERN PENNSYLVANIA

GAME AND FURBEARERS

For convenience, all of the mammals that are hunted for sport or trapped for fur are grouped in this section. They include the following species and are arranged in the order in which they are discussed:

White-tailed deer
Elk
Black bear
Snowshoe hare
Cottontail rabbit
Gray squirrel
Fox squirrel •

Red squirrel
Woodchuck
Raccoon
Opossum
Beaver
Muskrat
Skunk
Mink

Least weasel
New York weasel
Bonaparte weasel
Red fox
Grey fox
Dogs, coyotes and
wolves

WHITE-TAILED DEER

Odocoileus virginianus borealis

DISTRIBUTION. Deer are generally distributed in all counties coming even to the outskirts of the larger cities.

HABITAT. Primarily forest and forest edge. Although in its range it utilizes open fields, it is still dependent upon the proximity of the forest for cover in northwestern Pennsylvania.

NOTES. "Of especial interest in this section is the great abundance of deer which have, and are continuing to produce marked changes in the vegetation of the forest. Overbrowsing has practically eliminated yew, hobble bush (*Viburnum alnifolia*) and (*Viburnum acerifolium*) and painted trillium. Hemlock is the only tree that is being reproduced and only a few young hemlocks survive to get above the browse line. Beech, maple, oaks are all browsed to the ground. In addition to the effects of overbrowsing, deer have trampled out many of the creeping perennial plants, and in places the soil has the compacted appearance of an old sheep pasture."

The above field notes describing conditions in northern Jefferson County, May 1949, are applicable to most of the forests of the high plateau section. Correlated with the scarcity of natural food is the increased dependence on man's crops and an increase in deer damage complaints. In the less extensive forests to the west and south such extreme overbrowsing is not apparent.

In the Potato Creek Valley in southeastern McKean County deer were observed every evening for three weeks. In this valley there are fields bordered by extensive stream-side thickets. At the season we were there (August 1948) the fields contained ripe and shocked oats, buckwheat in full bloom, green corn, good second growth clover and alfalfa and occasional abandoned fields. With this variety of food available, it was noted that all of the deer seen, from six to ten in number every evening, and usually in groups of two or three, were feeding in the hay fields. During the three weeks none were seen in buckwheat. It appeared that cultivated areas were being heavily utilized as feeding grounds, and all the deer observed appeared to be in excellent condition.

In the Kinzua section in western McKean County twin fawns were common, and in Potato Creek Valley twinning appeared to be the rule rather than the exception. One evening three fawns were seen following the same doe, but whether or not there was another doe in the vicinity was not ascertained. It is of interest to note that in the Sigel area of Jefferson County where there is little highly productive farm land within the deer country, no twin fawns were seen or reported during our stay. The residents there consider twin fawns a novelty.

ELK

Cervus canadensis canadensis

NOTES. The native elk has been extinct since 1860-70 (Rhoads 1903).

At present there is an introduced herd in Cameron County from which occasional individuals have been reported in Elk and Forest Counties in this section.

BLACK BEAR

Ursus americanus americanus

DISTRIBUTION. Found in McKean, Warren, Elk, Forest, northern Jefferson and northern Clarion counties.

HABITAT. Forest. The black bear succeeds in maintaining its numbers only where there are large unbroken tracts of forests.

NOTES. Both the Kinzua and Clermont areas attract large numbers of bear hunters during the open season. Bear damage and bear kill records of the Pennsylvania Game Commission indicate that bears are more common in McKean County than in any other county in northwestern Pennsylvania. (Gerstell 1948).

Several bear scats were examined in the Red Mill Brook locality in August and were found to contain June berry (*Armelanchier*) blackberry (*Rubus*) and black cherry (*Prunus serotina*). Bears had torn open many rotting logs and stumps, most of which had contained colonies of ants.

Northern Jefferson County is another important bear hunting section, and from interviews there, we learned that bear feed through the vicinity of Pine Run and Clear Creek, but do not den there. Although bears are frequently seen during the summer months, none has been reported earlier than July in this section.

The black bear has been protected by law since 1905 (*Pennsylvania Game Commission Educational Pamphlet No. 3*, 1942) and has become an increasingly popular game animal since that time.

SNOWSHOE HARE

Lepus americanus virginianus

DISTRIBUTION. Generally distributed in the high plateau section but becomes local in its distribution south and westward. The following localities are at, or near, the periphery of its range in northwest Pennsylvania.

Western Warren County: The high ridges northwest and south of Pittsfield (including State Game Lands No. 143 and No. 86). Columbus Bog (State Game Lands No. 197). Benson Swamp, 5 miles east of Columbus.

Southeastern Erie County: 3 miles south of Corry.

Eastern Crawford County: The high ridges north of Titusville.

Northeastern Venango County: 6 miles east of Oil City.

Southeastern Jefferson County: The high ridges 10 miles southeast of Punxsutawney. This is at the junction of Jefferson, Clearfield and Indiana County lines.

HABITAT. In the high plateau section the snowshoe hare occurs in wooded areas generally although it is more numerous in those localities that have a dense undergrowth of laurel (*Kalmia*) and rhododendron. South and west it prefers the colder habitats afforded by the higher ridges or extensive swamps.

NOTES. Our primary objective for this species was to determine its present day distribution and the following notes are based upon observations and information obtained incidental to other studies in the areas where *Lepus* occur.

After reaching a low in numbers in 1945, they have been gradually increasing for the last three years. This decline and increase seems to be associated with the passing of the low in game species generally. Of more immediate importance than the fact that they are once more increasing is the question of how much of an increase can be expected in the overbrowsed forests where they occur. The best areas for the hares are located in the general region that has suffered most from an overpopulation of deer where many places appear to be deficient in both food and cover.

COTTONTAIL RABBIT

Sylvilagus floridanus meanrsii

DISTRIBUTION. Occurs in all counties.

HABITAT. The cottontail rabbit occurs in almost all habitats but is less numerous in dense forests and very open grasslands. Its optimum habitat is thicket or forest edge and brushy fields.

NOTES. This is the most important game animal in the state, in numbers killed annually, in numbers of people who hunt it, and in the amount of money expended annually for importation, transfer, and research, in efforts to increase their numbers. With the intensive work that has been, and is being done, on rabbits, we limited our work with this species largely to observation of food habits and examination of those rabbits that were taken accidentally, or during the hunting season. Rabbit food habits were noted in each locality. The following plants were noted as preferred foods during the spring and summer:

Dandelion (*Taraxacum officinales*). All parts of the plant were eaten although, when in bloom, the flower was eaten to the exclusion of anything else. Young rabbits were seen to select dandelion leaves out of patches of mixed dandelions, clover and blue grass. English plantain (*Plantago lanceolata*). The leaves are a preferred summer food. This plant is commonly available in lawns and in pastures.

Clovers (White and Red). Important food plants at all seasons when not covered by snow. Grasses; all of the common pasture and lawn grasses appear to be eaten. Those that remain green through the winter are important as sources of food in the spring after the snow melts.

During midsummer to early fall the green foods of early summer are supplemented to a considerable extent by grass seeds. Seed heads of the following grasses were extensively eaten by rabbits: Timothy, orchard grass, red top, blue grass and poverty grass (*Danthonia spicata*) and other wild grasses.

Also utilized during late summer and fall was swamp milkweed (*Asclepias incarnata*). This appeared to be a preferred food wherever it was present along streams and in wet parts of fields.

Sweet Clover (*Melilotus*). Although the mature summer growth was not often observed eaten, wherever there were good stands of second growth sweet clover, rabbits were observed to feed on it.

Blue False Indigo (*Baptisia australis*). This legume was found only along gravelly shores of the Allegheny River, but in September it had been severely cut by rabbits.

In some localities some species of aster and of goldenrod were heavily utilized while other species of these plants were not eaten.

Of special interest is the preference for plants of European origin that are ordinarily associated with farming. Not only is this true of the better cultivated grasses and clovers, but of such weeds as dandelion and English plantain. This preference may explain, in part, the phenomenon so often observed on abandoned farm lands where for the first few years following abandonment rabbits increase, and then gradually decrease until finally there are fewer rabbits in what appears superficially to be better cover than there was at the time of abandonment.

On most soils of northwest Pennsylvania the various grasses and weeds of European origin grow rapidly for a few years following abandonment but are then replaced by native grasses and weeds of lower palatability. Although no study was made of this important phase of habitat change, two factors were noticed that are influential in delaying this change. On fertile soils the change is slower as evidenced by the observation that old house or barn sites are frequently marked by a patch of orchard grass and European weeds long after the adjacent fields have reverted entirely to native plants. The other factor that tends to maintain good forage plants is moderate grazing or mowing. Although our better pasture and hay grasses and legumes are able to withstand grazing or mowing, they are intolerant of plant competition that overshadows them, with the result that even on soils of high fertility the more palatable vegetation is gradually shaded out by tall native weeds and coarse grasses.

Detailed winter food studies of rabbits of Pennsylvania were reported by Beule (1942). He found that the utilization of woody plants was correlated with snow, herbaceous plants being preferred as long as they were available. During December 1946 and January 1947 the ground was not covered with snow enough to prevent rabbits from feeding on herbaceous plants, including those grasses that remain green all winter.

Along right-of-way clearings, the dense low growth of hardwood sprouts was utilized by both rabbits and deer. Many ironwood trees (*Carpinus caroliniana*) growing in poorly drained bottom lands have a dense growth of fine sprouts (1/16 to 1/8 inch in diameter) around the base of the tree. These may form a patch several inches to a foot in diameter. Wherever observed they showed sign of having been browsed for several seasons. One rabbit fed entirely on these ironwood sprouts and hemlock twigs during the period of observation lasting from February 11 to March 11, 1947.

Rabbits were also observed to bark crab apple and domestic apple branches wherever available, but since they are available only where they have been cut and piled on the ground, they are not normally an available source of food, although they seem preferred.

Probably indicative of an available supply of food plants was the observation that no trees or shrubs over two inches in diameter were barked in any of the areas examined during the winters of 1946-47 and

1947-48, and only those under three quarters of an inch were utilized extensively. During the coldest days of January 1948, when the minimum temperature was below -12° F, rabbits were not active. On one occasion, following a severe drop in temperature, the rabbits in one locality did not come out until the fourth day, and when they did come out they fed on blackberry briars within fifteen feet of the groundhog burrows they were occupying. Then as the weather grew milder, they foraged farther to where they could get fallen apples. In one locality the frost-killed stems and leaves of second growth sweet clover was a preferred food. This stood up well above the snow and was available all winter.

It appears that the blackberry is the most important single winter food plant for rabbits in this area, with black raspberry second only because it ordinarily does not occur in the same abundance as blackberry. Sumac sprouts are a preferred food, but in the northern counties there are rarely enough sumac of small size in any one area to be important.

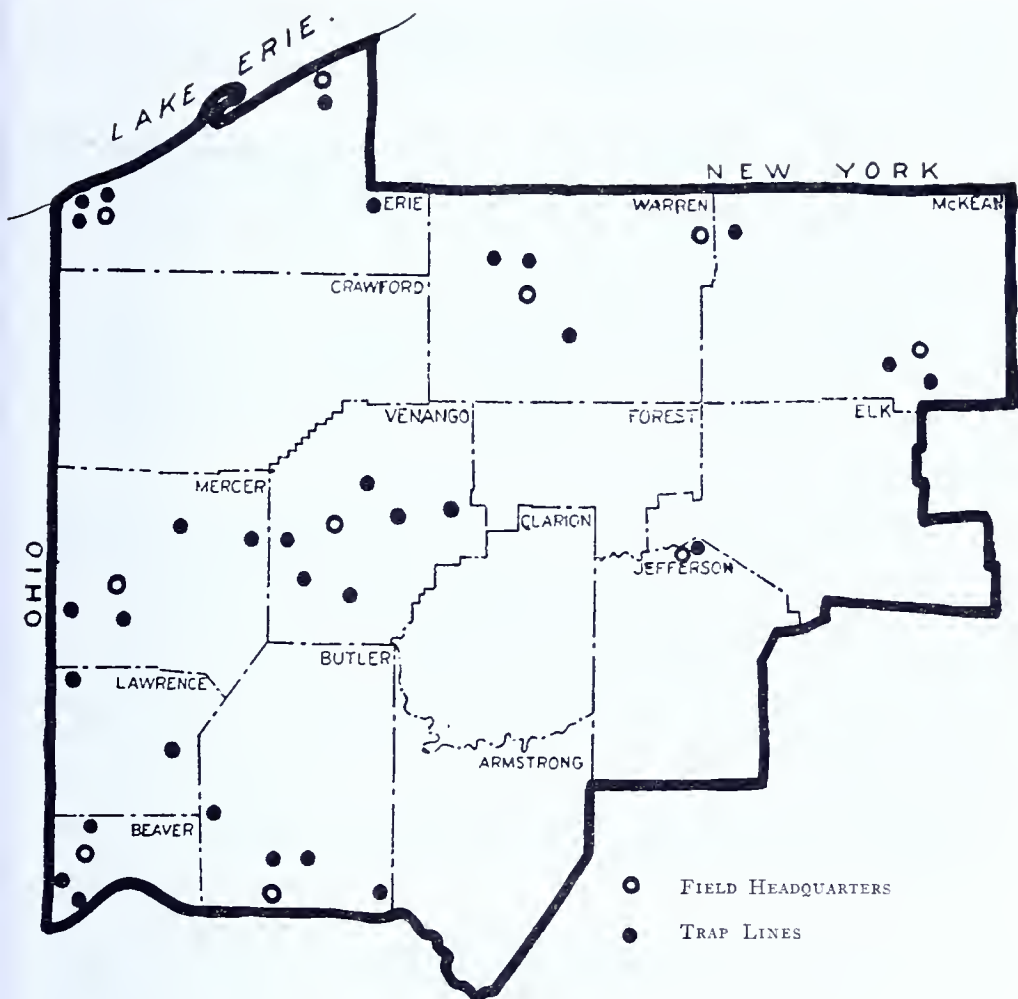
The following table shows the woody plants that were utilized by wild cottontails in Venango County during the heavy snows of February, March and April, 1947.

Date		Plants eaten	Plants not eaten
Feb.	11	1* Ironwood sprouts under $\frac{1}{8}$ " in diam. 1 Tips of Hemlock branches.	In this locality there was little else available.
Feb.	11	1 Blackberry 1 Black Raspberry 2 Red Osier 3 Black Willow	Common Willow sprouts Elderberry Alder Elm sprouts
Feb.	11	1 Blackberries 1 Sumac under $\frac{3}{4}$ " † Ornamental trailing <i>Evonymus</i>	Red Osier Wide variety of ornamental shrubs and evergreens
March	11	1 Blackberry 1 Sumac under $\frac{3}{4}$ "	Red Maple Crab-apple Blueberry
March	28	1 Sumac under $\frac{3}{4}$ " 1 Crab-apple under $\frac{1}{2}$ "	
March	31	1 Blackberry 1 Sumac under $\frac{3}{4}$ " 3 Sumac over 1 yr. old	Alder Black Cherry Elderberry
April	8	2 Crab-apple under $\frac{1}{2}$ " 1 Blackberry 1 Black Raspberry 3 Red Raspberry	Black Cherry Aspen
April	8	2 Elderberry 3 Sycamore sprouts $\frac{1}{2}$ "	Black Cherry sprouts

* 1 indicates plants generally eaten; 2, plants occasionally eaten; 3, plants rarely eaten.

† Only one clump present in edge of shrub border and it had been severely browsed.

Specimens taken: 35—Beaver 4, Butler 3, Erie 9, Forest 1, Jefferson 4, McKean 1, Mercer 1, Venango 11 and Warren 1.



MAP 5. DISTRIBUTION OF AREAS TRAPPED

GRAY SQUIRREL

Sciurus carolinensis leucotis

DISTRIBUTION. Occurs in all counties.

HABITAT. Forests. Although this squirrel may occur in small woodlots and wooded fencerows, its optimum habitat is larger tracts of woodland.

NOTES. Squirrels feed on a wide variety of nuts and seeds, but in northwestern Pennsylvania the following trees supply the most important winter foods: pines, oaks, hickories, black walnuts and butter-nuts. In the southern and western counties, the walnuts and hickories are sufficiently numerous and well distributed to be especially important. During the summer, maple seeds, Juneberry, and later black cherry are

important foods. In the fall, both wild grape and the small berries of the black gum are eaten, and in season, poplar, hazelnuts, corn, and fruits of the cucumber tree.

The numbers of squirrels in any one locality vary greatly from year to year, and are apparently correlated with good or bad mast years. No gray squirrels were seen near Clermont in McKean County, and no sign that could definitely be ascribed to this species was observed. Good den trees are not numerous. Nut and mast species are likewise few in number. Sugar maples of bearing age are present in numbers sufficient to provide ample summer food, and it is possible that the lack of squirrels in this area may be the result of an inadequate dependable winter food supply.

In contrast, western McKean County, near Kinzua, has a large number of mature, unsound trees, many of them sugar maples and butternut. Gray squirrels were found to be abundant there. In Warren, McKean, Elk, Forest and the northern part of Venango, Clarion and Jefferson Counties, in the High Plateau section, from 25% to 50% of the population is melanistic. This is in striking contrast to areas west and south of this where the occurrence of a black squirrel is sufficiently rare as to be a novelty.

Specimens taken: 22—Beaver 5, Erie 3, Jefferson 5, Mercer 1, Venango 4 and Warren 4.

FOX SQUIRREL

Sciurus niger rufiventer

DISTRIBUTION. Probably a few in all counties. The fox squirrel was originally native to the western counties and along the Lake Plain. This squirrel has been imported and released in all counties, but at present, only in the glaciated portion of this section are they numerous enough to be an important game animal.

HABITAT. Woods and thickets. The difference between the habitats of the fox and gray squirrels are not easily defined. In much of western Pennsylvania the two squirrels occur together in the same woods. The fox squirrel prefers more open woods, or forest edges. Just a row of trees along a fence or stream is sufficient for these animals. They thrive in pastures where there are scattered trees or in bushy fencerows. They do not penetrate far into the large forests north and east of Venango County.

Specimens taken: 14—Beaver 3, Erie 9, Mercer 1 and Venango 1.

RED SQUIRREL

Tamiasciurus hudsonicus loquax

DISTRIBUTION. Occurs in all counties, but very scarce in Beaver, Lawrence and western Mercer Counties. In the northern counties it is generally distributed and locally abundant.

HABITAT. Forests and thickets. Not restricted to any one forest type but apparently reaches its greatest abundance in forest with dense top growth. Dense top growth is characteristic of hemlock and white pine forests as well as the spruce forests in other states. Writers generally have considered this squirrel to be more or less restricted to the northern coniferous forests, however, it is equally abundant in dense thickets or in hardwoods that have a dense tangle of wild grape. In the glaciated northwestern part of our area, many fields are separated by old stone fences that have grown up in a dense tangle of sumac, black cherry, sassafras and wild grape that supports a population of red squirrels.

NOTES. The food of the red squirrel consists of a wide variety of seeds and nuts, insects, small birds and mammals. Like the flying squirrel, they are often taken in meat-baited traps set for weasels. In the fall they cache large quantities of seeds and nuts for use during the winter. In this they differ from the gray squirrels in one interesting respect: Red squirrels usually bury a quantity of seeds and nuts in one hole instead of burying each item separately as do the gray squirrels. Several caches examined contained $\frac{1}{4}$ to $\frac{1}{2}$ pint of seeds, each cache consisting of all seeds of the same kind. Of those buried most frequently are witch-hazel seeds (these were buried in the seed pods), acorns, hemlock cones and pine cones.

The red squirrel spends much time foraging on the ground and examines every stump, log pile and brush heap in its range much in the manner of a weasel.

In the winter, when there is deep snow on the ground, they construct long and intricate tunnels under the snow, sometimes connecting every tree in a patch of woods. Our observations indicate that these tunnels were used most in subzero temperatures and that in the mild periods of winter these squirrels were more active on top of the snow.

REPRODUCTIVE DATA

Date	Embryos	Size	Scars	Remarks
Aug. 31, 1946			5	2 sets of scars visible
Feb. 21, 1947	6	Under 1 mm.		
Mar. 15, 1947			7	Old scars
Mar. 3, 1946	3	Under .5 mm.		
Mar. 15, 1948				Not pregnant
June 17, 1948			4	Recent scars; not lactating
Aug. 16, 1948			6	Not lactating

Specimens taken: 41—Allegheny 1, Butler 2, Erie 7. Jefferson 2, McKean 1, Venango 17, and Warren 11.

WOODCHUCK or GROUNDHOG

Marmota monax monax

DISTRIBUTION. Occurs in all counties.

HABITAT. Occurs in all habitats except in extensive swamps and marshes. The most favorable habitat is forest edge and grasslands with sufficient cover, such as brushy fencerows.

NOTES. Although once classed as an agricultural pest with no redeeming features, the groundhog while no less a pest than ever, has in recent years become a highly popular game animal for the rifle enthusiast. The increasing knowledge of the importance of groundhog burrows as shelter and escape cover for rabbits and other forms of wild life has given the groundhog a place in wildlife management.

Groundhogs reach their maximum numbers in and around hayfields as the production of hay supplies optimum conditions of dense cover with the maximum amount of preferred food. This is especially true where clover, alfalfa or soybeans are grown extensively. In such places groundhogs will have large permanent burrow systems in fencerows or margins of the field, but as soon as the hay is high enough to afford cover, they will construct burrows out in the field. Often these will be deserted when the hay is cut only to be reoccupied as soon as the new growth is high enough to afford some cover.

The food of the groundhog consists of a wide variety of forage plants, nuts and fruits. Most legumes appear to be preferred food. In one locality groundhogs were feeding extensively on white clover although this necessitated travelling 30 feet through other forage plants. Most of man's crops are preferred foods of the groundhog to such an extent that control measures are often necessary to reduce their numbers. However such control measures should be local, for where the groundhog is not doing actual damage, it is benefitting other forms of wildlife, and should be encouraged. Of the mammals that occur in Pennsylvania, the groundhog is the principal excavator of large burrows that are in turn used by skunks, opossums and foxes. These burrows are apparently necessary for rabbits if they are to survive periods of severe winter weather. At all time of the year groundhog burrows are important escape cover for rabbits.

In the high plateau section including Warren, Elk, McKean, Forest and the northern part of Venango, Clarion and Jefferson Counties the melanistic or black phase of woodchucks is relatively common but not nearly as common as black squirrels, in this same area. Although it was not possible to estimate the percentage of black woodchucks, it is less than five percent.

Specimens taken: 46—Beaver 5, Butler 3, Erie 1, Forest 1, Jefferson 5, McKean 6, Mercer 6, Venango 5, and Warren 14.

RACCOON

Procyon lotor lotor

DISTRIBUTION. Generally distributed in all counties.

HABITAT. Forest and forest edge. The most favorable habitats are wooded areas along streams or wooded swamps.

NOTES. The 'coon, once scarce in this section, was extensively restocked from 1925 to 1935. In the last five years it has become so abundant that in 1946 the hunting season was extended and trapping was permitted. At the present, the raccoon is generally abundant although there are a few local exceptions. The raccoon is omnivorous. Small grain and corn are favorites while the grains are still soft. Most of the fruit and berries, wild and domestic, are eaten as well as acorns, crawfish, fresh water clams and salamanders. They also feed to a limited extent on mice and birds.

Specimens taken: 21—Crawford 3, Erie 1, McKean 1, Mercer 2, Venango 9, and Warren 5.

OPOSSUM

Didelphis virginiana virginiana

DISTRIBUTION. The opossum occurs in all counties although it is less abundant in McKean, Elk and northern Jefferson. It appears to reach its greatest abundance in the western counties. We have some evidence, although not conclusive, that opossum attain greater size in the western counties than they do elsewhere in this area.

HABITAT. Forest and forest edge. As would be expected of an animal that occurs over all of the eastern United States from Florida to New England, the habitat requirements of the opossum are rather easily met. This animal is equally at home in the woodlots and thickets of the agricultural section and the dense forests of the mountains. It is one of those animals whose ability to thrive in the proximity of man has enabled it to expand its range and to increase its numbers with the settling of the country.

NOTES. The food of the opossum is primarily carrion and fruits and insects in season. Those taken in the vicinity of farms generally contain evidences of having fed on refuse. Their fondness for carrion causes many of them to be taken in traps set for foxes.

Females with young in the brood pouch were taken in May, August and September.

Specimens taken: 24—Allegheny 2, Beaver 6, Butler 6, Crawford 1, Jefferson 3, Lawrence 1, Mercer 2, Venango 1, and Warren 2.

BEAVER

Castor canadensis canadensis

DISTRIBUTION. Within historic times the beaver occurred in all counties, but prior to 1900 it was extinct in this section. Following a program of restocking and protection begun in 1917, the beaver in 1934 had once more reached numbers that permitted the harvesting of a surplus.

Today beavers occur in all counties of northwest Pennsylvania except Beaver and Lawrence. Crawford County leads in the number of beaver trapped, 389 being taken in the two week open season in February 1948. The following list from the records of the Pennsylvania Game Commission shows, by counties, the number of beaver taken in this area during the open season of 1948:

Armstrong	11	Lawrence	0
Beaver	0	McKean	212
Butler	24	Mercer	49
Clarion	44	Venango	73
Crawford	389	Warren	239
Elk	201		
Erie	159	Total	1549
Forêt	127		
Jefferson	21	State Total	2910

This shows that 6 northwestern counties produced 46% of all the beaver taken in Pennsylvania in 1948.

The weather during the season of 1948 was mild and unusually favorable for beaver trapping so that figures for the take of 1948 should not be considered the number that could be removed annually. In fact, overtrapping was sufficiently severe that these counties were closed to beaver trapping in 1949. However, these figures do indicate the relative size and importance of the present day beaver population in this area.

NOTES. The history of the beaver in Pennsylvania up to 1900 is reviewed by Rhoads (1903) and the subsequent history of restocking, protection and development of the present beaver population is described in detail in *Pennsylvania Game Commission Educational Pamphlet No. 4* (1942).

MUSKRAT

Ondatra zibethica zibethica

DISTRIBUTION. Generally distributed and common along streams in all counties.

HABITAT. Shore lines of streams, lakes, ponds and marshes. The muskrat is tolerant of a wide variety of conditions and a few will occur in almost any place that has water. Suitable marsh habitats are extensive in this section only in the extreme northwestern corner of Pennsylvania in parts of Mercer, Crawford and Erie counties. Elsewhere in the section, muskrats live along streams. The slow moving streams of the western counties are more suitable than the rocky, fast flowing streams of the Allegheny Plateau. Since muskrats that live along streams construct dens in the banks of the stream, two of the limiting factors in this section are: floods that cut away the stream banks; and pasturing of stream margins that keeps trampled such dens as are constructed.

NOTES. The most important factor in determining the number of muskrats present during the trapping season appears to be the weather of the preceding eight months. The reproductive capacities of the muskrat are so great that usually one good season will enable them to build up to high population densities. The factors that constitute a favorable season for muskrats in this area are: no floods during May and June, and normal to excess rainfall in late September and October. However, serious floods or severe drought at any time of the year act to reduce the number of muskrats. (Richmond 1947.)

In addition to these two periods that are especially critical for muskrats, the weather during the trapping season is an important factor in

determining the number trapped. Floods, or even fluctuating water levels hinder trapping, as do very deep snow or thick ice. The effects of bad weather in the trapping season not only interferes with the orderly harvest of this important fur-bearer, but also contributes to the difficulty of obtaining population data from fur records.

In the past three years, we have found no evidence that diseases or parasites were important factors in causing the observed population changes in muskrats in this area. This apparent freedom from serious disease may be, in part, due to the prevailing low population of muskrats here in 1946-47 and 1947-48.

SKUNK

Mephitis mephitis nigra

DISTRIBUTION. Occurs in all counties.

HABITAT. Not restricted to any one habitat but reaches its maximum abundance in more or less open woods or brush grown fields, and is scarce in unbroken forests.

NOTES. The skunk feeds primarily on fleshy fruits and insects supplemented by small mammals, frogs, snakes, and eggs of ground-nesting birds. From mid-summer on to cold weather, food is plentiful with the succession of ripening strawberries, blackberries, wild cherries and pokeberries. In fall, grasshoppers appear to make up the bulk of the skunk's diet. Although they are often accused of raiding poultry houses, this seems to be a trait only of certain individuals as instances are known of skunks living around chicken houses and never bothering the chickens. In the vicinity of streams, turtle nests are dug up and the eggs are eaten.

As a fur-bearer the skunk is second in importance only to the muskrat.

In the years 1942 to 1944 the skunk population was at a high and then, as a result of a disease, the population dropped to what, according to fur buyers, is an all-time low in their experience. Studies made in Ohio and Michigan found rabies and an unknown type of encephalitis. (Gier 1948.) Whatever the disease was, it spread through the skunks and virtually eliminated them. As the situation appears now in 1948, the skunk population is again increasing but is still low in Butler, Beaver, Mercer and Crawford counties. Skunks are common to abundant in eastern Erie County, and in much of Warren County. East of the Allegheny River they appear to be common. However, trappers say that they are less numerous than they were a few years ago.

In the Allegheny Valley, north of Kinzua, there is what appeared to be an unusually high population of skunks, and even more unusual was the uniform appearance of them. Those we examined were almost identical in their patterns. The white stripes on the back were broad and ended in a wide hook extending down over the flanks. The tails were composed of coarse white hairs with black tips. The fur buyers in north-western Pennsylvania are apparently familiar with this local population as they refer to them as "monkey tails" and state that they are almost worthless.

Specimens taken: 29—Beaver 1, Crawford 6, Erie 1, Jefferson 3, McKean 1, Mercer 6, Venango 4 and Warren 7.

MINK

Mustela vison mink

DISTRIBUTION. Generally distributed in all counties.

HABITAT. Not restricted to any one habitat. Ordinarily thought of as associated with streams, the mink is equally at home on dry rocky ridges, open fields, and dense forests. Evidence of its habitat tolerance is its ability to thrive in the suburbs of the largest cities and in small towns.

NOTES. The mink occurs over most of North America from Florida to Alaska and so is not only successful in a wide variety of habitats, but feeds on a great variety of foods. However, so far as known, it is entirely carnivorous. What constitutes the bulk of its diet is determined largely by season and availability. Mice, fish, crawfish, frogs and muskrats are staples; rabbits, birds and snakes when available. Although one of the most prized furbearers in the state, some trappers feel that the damage they do to the muskrats is greater than the value of the mink. Part of this feeling comes from the fact that the mink is not above robbing traps, and at the same time, is difficult to catch. Like a fox, a trap-wise mink is enough to challenge the best trapper.

Obtaining definite information on the food habits of the mink is not easy as most trapped specimens have empty stomachs, and quite often have no evidence of food in their intestines. Of 27 winter-trapped animals that were examined, only 10 had any food remains at all in their stomachs, and only 15 had any recognizable food remains in their intestines.

The following list shows the items of food and the number of mink in which they occurred:

Fish	5	Deer Mouse	1
Frogs	4	Shrew	1
Crawfish	2	Grebe	1
Muskrat	2	Grasshopper	1

Although crawfish occurred twice, examination of droppings during the summer indicated that, along those streams where crawfish were numerous, they were heavily utilized.

Most trappers interviewed are of the opinion that mink are more numerous now than they have been for a long time and our impression is that mink are increasing in this section, although trapping pressure as a result of high prices is also increasing.

In 1948 both the mink and muskrat trapping seasons were shortened and limited to the month of December. This had the effect of practically eliminating mink trapping in sections where there are good muskrat marshes as it was more profitable for trappers to spend the short time available trapping muskrats.

Specimens taken: 40—Allegheny 1, Butler 1, Crawford 27, Jefferson 1, Lawrence 1, McKean 1, Mercer 2 and Venango 6.

LEAST WEASEL

Mustela rixosa allegheniensis

DISTRIBUTION. Occurs in all counties.

HABITAT. Since we caught only three of these little animals, the only information that we have on their habitat preference is a description of the places where those three were trapped. One was taken in relatively dry grassland; the second was in an underground runway around the edge of a marsh; this same trap caught two *Blarina*, one crawfish, one Star-nosed mole; the third least weasel was taken in a stone pile in a brush-grown abandoned field. All three habitats had a high population of meadow mice.

NOTES. We examined five of these carnivores and the stomach and intestines of each was empty. One of the three we trapped was carrying a meadow mouse at the time it was caught. In the same locality a few days before, our attention had been attracted by a mouse squeaking loudly. Suddenly a large meadow mouse ran out of the grass and stopped in plain view in the open, apparently uninjured. Since nothing was following it, it was picked up and examined, and although there were only two punctures in the skin, an $\frac{1}{8}$ of an inch (3 mm.) apart, there was a series of small needle-like punctures in the base of the skull. The mouse had obviously been attacked by a very small weasel, and the injuries had been made by an animal with teeth smaller than those of even a young of the common weasel.

Most of our information on the distribution of the least weasel has been obtained through the cooperation of Mr. Harold L. Plasterer, Predator Control Assistant, and his assistants in the Bounty Division of the Pennsylvania Game Commission in Harrisburg. Since February 1948 they have kept a record of the locality data on all least weasels submitted for bounty. An analysis of these records for the eleven month period from February to December, 1948, for the counties covered by this report is included here.

County	Total No. Weasels	Least Weasels
Allegheny	91	2
Armstrong	247	8
*Beaver	14	0
Butler	321	8
†Clarion	339	0
Crawford	334	5
Elk	178	1
Eric	218	10
Forest	45	1
Jefferson	344	3
Lawrence	47	7
†McKean	190	0
Mercer	255	7
†Venango	230	0
Warren	186	2
	3,039	54

* Beaver County. Since this list was prepared, one *least weasel* has been probated for bounty from this county.

† Clarion County and McKean County. *Least weasels* have previously been reported from these counties. See Sutton (1929).

‡ Venango County. *Least weasel* is known to occur here and one of the specimens taken by us was near Franklin.

NEW YORK WEASEL or COMMON WEASEL

Mustela frenata noveboracensis

DISTRIBUTION. Generally distributed and common in northwest Pennsylvania except in Beaver County where all weasels appear to be scarce.

HABITAT. No marked habitat preference. In winter their tracks are most numerous in thickets or brushy areas along streams.

NOTES. Weasels are entirely carnivorous and for the most part feed on small mammals, birds, and occasionally, insects.

The winter fur of this weasel may be white or brown although the brown is more common. Insufficient numbers were seen to determine whether or not the northern counties produced more white weasels than the counties farther south. However, white weasels were seen from northern Allegheny County.

A state-wide bounty has been paid on all weasels since 1915. In the first twenty years (1915-1935) the number of weasels presented annually for bounty varied from a high of 88,578 to a low of 22,583, with an annual average for the period of 52,244. (Gerstell, 1937.)

Comparing these figures with the bounty records for the last ten-year period (1938-1948) we find a high of 40,867, which is less than the first twenty year annual average, and a low of 5,487. The annual average for this recent ten-year period is 20,381.

In the twenty-five years from 1915 to 1940, the lowest number of weasels to be presented for bounty in any one year was 22,583 in 1924-25, and this twenty-five year minimum is higher than any year since 1940. In fact, the number of weasels offered for bounty has, for eight years, been lower than at any time in the history of Pennsylvania's bounty system.

A number of factors contribute to this decline in bounty figures. One has been the prevailing high fur price for weasels which reached a peak in the winter of 1947-48 when large weasels brought \$3.50, and the average was selling for higher than the bounty rate of \$1.00. More important, there appears to have been an actual decline in the number of weasels from the peak populations of 1930-37. That there has been a drop in the number of weasels is confirmed by interviews with trappers and fur-buyers.

It appears, then, that some natural factor has operated to reduce the number of weasels, and whatever the factor is, it has been more effective than thirty years of bounty payments. In view of the low population density and the current good demand for weasel fur, it does not seem necessary to subsidize weasel trapping.

Specimens taken: 47—Allegheny 2, Beaver 1, Butler 6, Crawford 11, Jefferson 5, Mercer 6, Venango 12 and Warren 4.

BONAPARTE WEASEL

Mustela erminea cicognanii

A third weasel, *Mustela erminea cicognanii*, occurs in this section but it appears to be relatively rare. Specimens were examined as follows:

Western Crawford County	1	Forest County	1
Eastern Erie County	1	Elk County	3

FOXES

Red Fox—*Vulpes fulva fulva*

Gray Fox—*Urocyon cinereoargenteus cinereoargenteus*

DISTRIBUTION. Generally distributed in all counties.

HABITAT. As nearly as we could determine from observations, and from interviews with trappers, there is no difference in the habitats of the red and gray foxes in this section. Neither fox is limited or restricted to any one habitat. To an animal as wide-ranging as the fox, our habitat classification of field or forest does not apply as neither classification occurs in a large unbroken unit. In fact, to such wide ranging forms, the whole area is forest edge.

NOTES. Mammals, fruits, insects and birds constitute the bulk of the foxes' diet.

The ratio of red to gray foxes in the northern counties has changed in the last ten years with the gray foxes becoming relatively more numerous. The great increase in numbers of both species, however, exaggerated the apparent increase in numbers of gray foxes. For example, in Crawford County in 1940, there were 5 red foxes to every 1 gray fox offered for bounty, while in 1946, the ratio was 3 to 1, but at the same time in that county, there were 6½ times as many gray foxes taken in 1946 as in 1940. This convinced many people that the gray fox had "moved in" to the area about that time, and that it had not previously occurred there.

As the most abundant and widely distributed large predators in the state, foxes have been subject to efforts to control their numbers since the middle of the nineteenth century. (Gerstell 1937.) Since 1915 this control has operated through a state-wide bounty system that has been in effect continuously on the gray fox, but has been lifted occasionally on the red fox because of its fur value and sporting value.

Since 1944 the number of foxes of both species has been at an all-time high in Pennsylvania as well as throughout most of the northeastern states. It is generally thought that this marked increase in numbers is the result of reduced trapping pressure caused by the drop in price of fox fur and by the number of trappers who were away in the armed services or in war industries.

Although the price for red fox fur dropped, the price for gray fox fur has varied only slightly from its long term average of \$1.50. In Pennsylvania the fur value of a gray fox pelt has usually been well below its bounty value of \$4.00.

As an indication of the amount of trapping pressure on foxes during the war years, we have the bounty records for those years showing the number of gray foxes on which bounties were paid. (The figures used are totals for the entire state.) No bounty was paid on red foxes from June 1942 to July 15, 1945 inclusive. The number of gray foxes offered for bounty has increased steadily since 1941, and during the four years June 1942 to May 1946, bounty was paid on 47,760 gray foxes. During the highest previous four-year period, June 1936 to May 1940, there were 38,660 gray foxes presented for bounty.

The number of people employed in war industries and in the armed services reached a maximum in 1944 and continued with little change until late 1945 or early 1946. Yet during the war years more gray foxes were offered for bounty than in any other four year period in the history of the bounty system in Pennsylvania!

The red fox was put back on the bounty list on July 16, 1945, and in *three* years, July 16 1945 to May 31, 1948, 126,745 foxes of both species were probated. This is approximately equal to the total number of foxes of both species offered for bounty in the first *thirteen* years that the present bounty system was in operation.

When the population of foxes increases to the extent that it has in the last nine years, it poses serious problems not only to the game manager, but to agriculture and to public health.

In a review of the problem of rabies in foxes, Gier (1948) states that in Ohio, "This toll of \$8,000 to \$10,000 or even more per county per year in livestock, plus \$1,000 to \$11,000 per county per year for rabies vaccination, plus the discomfort and worry involved, must be charged to rabies, at least part of which is transmitted by foxes . . . in both New York and Alabama, most of the loss was charged directly to foxes."

He also cites figures from Georgia for one year, 1946, showing that 106 people were bitten by rabid foxes and had to take treatment in addition to a known loss of over \$138,000 worth of livestock!

Out of all the statements that have been written concerning the values and effects of the bounty system, and the destructiveness of foxes, several facts are apparent:

1. The fox population has increased phenomenally since 1936.
2. The operations of a well managed and well supported statewide bounty system was not effective in preventing or halting this increase.
3. The payment of bounty has caused the removal of more foxes than would otherwise have been taken at the prevailing prices for fox fur.

And many questions remain unanswered of which the following seem important:

1. Has any game species or group of species benefited in proportion to this cost?
2. Has the loss of poultry as the result of fox predation been less in Pennsylvania than in surrounding states?
3. How does Pennsylvania compare with surrounding bounty or non-bounty states in losses of dogs, livestock and human cases of rabies?

In other words, the bounty system, for all its lack of effectiveness in controlling the numbers of a predator, may prove to be an economically practical means of dealing with the *eruptive phases* of predator populations.

For those who would argue that a high population will naturally decline, it should be emphasized that with foxes, one of the most frequent causes of the decline is rabies, and as Gier points out, "... the artificial reduction of population is not so wasteful of wildlife as is the unhampered disease, and it is less dangerous to man and domesticated animals."

TABULAR SUMMARY OF KILL RECORDS FOR NORTHWESTERN
PENNSYLVANIA BY COUNTIES

<i>County</i>	<i>Area Sq. Mi.</i>	<i>1. % in Farms 1945</i>	<i>2. Foxes Per Sq. Mi. 1946</i>	<i>3. Deer Kill Per Sq. Mi. 1940</i>	<i>4. Bear Kill 1947</i>	<i>5. Beaver Trapped 1948</i>
Armstrong	653	62.5	1.0	.91	0	11
Beaver	429	55.6	1.8	.21	0	0
Butler	790	60.8	1.1	.76	0	24
Clarion	601	54.5	1.3	2.28	3	44
Crawford	1,038	74.5	.9	.54	0	389
Elk	806	12.0	.8	22.40	15	201
Erie	781	73.4	1.0	.29	0	159
Forest	424	7.7	1.2	16.20	33	127
Jefferson	666	48.2	1.3	3.20	19	21
Lawrence	360	73.5	.6	.16	0	0
McKean	987	16.3	1.1	15.30	47	212
Mercer	700	80.5	.7	.18	0	49
Venango	661	40.0	1.0	5.15	3	73
Warren	902	33.4	1.1	9.50	36	239

1. From Pa. Dpt. of Agriculture Statistical Yearbook, 1946.
2. Total of both red and gray foxes *offered for bounty* June 1946 to May 1947.
3. Includes deer of both sexes killed during the open season of 1940.
4. Bear killed during legal open season of 1947.
5. Beaver taken during two-week open season of February 1948.

DOGS, COYOTES and WOLVES

The occasional occurrence of coyotes (*Canis latrans latrans*) and the ever-present large, feral dogs keep the newspapers supplied with "wolf" stories every hunting season. Four such stories originating in northwestern Pennsylvania during 1946-47 were investigated with the following results: 3 large feral dogs and 1 coyote.

In addition to these stories was another of an animal shot in Beaver County by Francis McChesney. This animal was identified as a coyote by Howard McClure, State Dog Law Officer, who examined the animal.

There was one wolf story that concerned a real wolf but it was a captive animal, and was shot in captivity, but somehow made the front page of the newspapers as being shot by a hunter.

The dogs and one coyote were of interest as they all came from approximately the same place (within ten miles of each other) and from all reports were hunting as a pack. These dogs were unusually large and heavy. The one coyote in this group was taken by John Powell in a fox trap near Dunham's Siding in Forest County, half-way between Tidioute and Tionesta, on the west side of the Allegheny River.

Although the eastern timber wolf (*Canis lupus lycaon*) has been extinct in eastern United States since before 1900, and Colonel Henry W. Shoemaker in his book *Extinct Animals of Pennsylvania* states the most recent authentic record of a native wolf killed in this state was in 1892, there is always the possibility of animals being found that have escaped from captivity. There is no evidence, however, that such escapes survive very long.

Information on the occurrence of the coyote was especially desired since unlike the timber wolf, this animal is adaptable and readily establishes itself and exists and increases in farming country. Although native of the west and mid-west, occasional individuals of this animal have been taken in most of the eastern states.

INSECTIVORES

In northwest Pennsylvania this group includes two moles and five shrews. The moles are distinctive in appearance and where they are numerous, they are known by the common names, hairy-tailed moles and star-nosed moles. The shrews, although often numerous, are usually inconspicuous, and for the most part, have no local names. This is generally true of small mammals. Only those that are especially numerous or distinctive in appearance have names in common use. Most small mammals are referred to by such collective terms as "mice" or "bats." So in order to discuss them it is necessary to use their technical names.

All of the shrews in Pennsylvania may be recognized by their long pointed heads and their chestnut-colored teeth.

HAIRY-TAILED MOLE

Parascalops breweri

DISTRIBUTION. This mole occurs in all northwest counties, and in western Pennsylvania, is the "common" mole. The so-called "common mole" of text books, *Scalopus aquaticus*, does not occur in western Pennsylvania.

HABITAT. This mole is found in all but the wettest habitats. Although common along streams, it apparently avoids soils that are wet and mucky. Otherwise it does not appear to be restricted and occurs both in cultivated fields and in dense forests. Although it is not restricted in its distribution by type of soil, it occurs in greatest abundance in those soils that are less compact. In the glaciated portions of this area it is especially abundant.

NOTES. These moles make extensive tunnel systems and in such systems there are main burrows or underground runways that may be used by more than one mole and various other small mammals. In one example: trapping in a runway approximately 7 inches below the surface yielded 6 *Parascalops* and 2 *Blarina* in 21 days of trapping. Other runways have produced 2 to 3 of these moles in 2 days' trapping.

In view of the general distribution of this mole, it is interesting to note that in the Allegheny Valley near Kinzua in June and July 1948, no specimens of this mole were taken, and no evidence of its presence was found, and at the same time the star-nosed mole, *Condylura*, was unusually abundant there.

Parascalops feed largely on insects of which ants and beetles form an important part of their diet. Thirteen stomachs of this mole were examined and the following food items found:

Name	No. of occurrences	No. of occurrences	% of total occurrences
INSECTS		34	58%
Coleoptera adults	7		
Coleoptera larvae	10		
Ants adults	9		
Ants eggs and larvae	3		
Diptera larvae	3		
Lepidoptera larvae	2		
OTHER ARTHROPODS		15	25%
Centipedes	7		
Millipedes	2		
Spiders	2		
Isopods	2		
Thysanura	1		
Acarina	1		
EARTHWORMS		5	8%
SNAIL (or slug)		1	2%
PLANTS		4	7%
TOTAL		59	100%

All of the moles had eaten one or more beetles (*Coleoptera*) or beetle larvae, and 10 of the 13 contained ants. Most of the stomachs contained small plant fragments, but the four listed as occurrences of plants contained 25% to 60% vegetable matter. This plant matter was not identified but appeared as fine fibrous roots. No stomach contained less than 3 different food items, and in some there were as high as 10 different kinds of invertebrates.

This mole occasionally is a nuisance, disfiguring lawns as it pushes its tunnels just under the surface, but in general, its activities are

beneficial. Although active throughout the year, during the winter months their activity is largely confined to the deeper runway systems. During warm periods when the ground thaws they are active near the surface of the ground. In the course of our work moles of this species were trapped every month except December, January, February and March.

Of 46 moles of this species examined, only three of them yielded any information concerning size of litters:

Date	Embryos	Size	Scars	Remarks
April 19, 1948 ..	8	14 mm.		
May 5, 1948			4	Recent birth
May 12, 1948 ...			4	Not lactating

Specimens taken: 46—Beaver 6, Butler 2, Erie 11, Jefferson 4, Lawrence 1, McKean 1, Mercer 18 and Warren 3.

STAR-NOSED MOLE

Condylura cristata

DISTRIBUTION. This mole is common to abundant in all localities.

It occurs in the Ohio Valley in Beaver County, and on the Allegheny Plateau in McKean County.

HABITAT. This mole occurs wherever the soil is saturated with water, whether in open fields or dense forests and its characteristic runways can be found around margins of streams, peaty swamps, wet fields and spring drains. It is not restricted to bottomland, but is found on steep slopes and in wet swales on the high ridges.

In two localities it was abundant in hay meadows. In one recently mowed field 18 mouse traps, set 10 feet apart in a windrow of spoiled hay, took 3 of these moles in 1 night, and 3 more in the course of a week. Fifteen were taken from approximately three acres here in 7 weeks. The soil in this field was a well drained, silty clay loam, and up to the time it was mowed, had a dense cover of timothy, red clover and orchard grass. No *Parascalops* were taken in this field. (2½ miles north of Kinzua, Warren County.)

In several localities as many as 3 individuals have been taken from one runway in 24 hours.

NOTES. Earthworms are the most frequently observed food. The digestive tracts of eleven of these insectivores, all caught during the summer months were examined. The results are shown in the following table:

Name	No. of occurrences	Name	No. of occurrences
Earthworms	10	Coleoptera larvae	2
Slugs	2	Centipedes	1
Diptera larvae	2	Ants	1
Lepidoptera larvae	1	Unidentified chitin	8

Earthworms were found in 10 of the 11 and in volume represented 90% of the food items found. One stomach contained only slugs (*Gastropods*), the remaining food items occurred only as traces. Eight of the stomachs contained pieces of chitin too minute to identify but indicating that the moles had fed on some insect or other arthropod.

One of these animals during six days in captivity ate approximately one quart of earthworms, six large crane fly larvae (*Tipulidae*), each approximately two inches long, and one salamander (*Desmognathus ochrophaeus*). It refused banana, pieces of raw meat, and canned dog food.

Star-nosed moles were obtained in all months except February and March although the December and January specimens were accidental catches by fur trappers in traps set for weasels around swamps.

This mole rarely comes into lawns and ordinarily its presence in a locality is unknown.

Specimens taken: 53—Beaver 4, Butler 7, Crawford 1, Erie 9, Jefferson 1, McKean 1, Mercer 6, Venango 2 and Warren 22.

MASKED SHREW

Sorex cinereus cinereus

DISTRIBUTION. Probably occurs in all counties but is more common northward. None were taken in southern Butler County, and only two in northern Beaver County.

HABITAT. *Sorex cinereus* is not restricted to any one type of habitat.

In Venango County where they were common they were found in dense woods, both evergreen and deciduous, and in open fields, although they were more numerous in the woods. They were found in both wet and dry situations although they were more numerous in the wetter places.

NOTES. In 7 stomachs examined, the principal food consisted of small spiders and occurred in 5 of the 7. Beetle remains were found in 3 and flies in 2.

Where these tiny shrews were feeding on mice in our traps, we noticed that they characteristically did not bite through bones but would leave even the fine ribs of a mouse they were eating. This was also confirmed by watching one in captivity. This observation is of interest since some of the studies based on examination of stomach contents and droppings have interpreted the absence of bone fragments as indicative that these shrews do not eat other small mammals. This habit of eating around the bones was found to be true also of *Sorex fumeus* and *Cryptotis*.

Nests of either this shrew or *Sorex fumeus* were found on several occasions. All of them were in cavities under rocks or logs. They were composed of entire leaves arranged in layers to line the cavity and fill it except for a small space in the center approximately $\frac{3}{4}$ inch in diameter. The nest is roughly spherical in shape and approximately three inches in diameter, and those examined had but one entrance. This habit of using entire leaves to construct a nest appears to be characteristic of the insectivores, as it has been observed for both species of moles, *Sorex fumeus* and *cinereus*, *Cryptotis* and *Blarina*. Three of these that were observed in captivity, *Blarina*, *Cryptotis* and *Sorex cinereus*, chose small pieces of paper for nest material in preference to either grass or cotton.

The masked shrew, like other shrews, does not hibernate, and is active on top of the snow even in coldest weather.

REPRODUCTIVE DATA

Date	Embryos	Size	Scars	Remarks
Jan. 21, 1948	4			
Apr. 15, 1948				Pregnant
Apr. 16, 1948				Pregnant
Apr. 17, 1948	5	Under 1 mm.		
May 3, 1948	8	Under 10 mm.		
May 5, 1948	6	9 mm.		
May 31, 1948	5	4 mm.		

Specimens taken: 78—Beaver 2, Erie 10, Jefferson 29, McKean 3, Mercer 1, Venango 24, and Warren 9.

BIG-TAILED SHREW

Sorex dispar

DISTRIBUTION. This rare shrew was taken in but three localities, one in northern Jefferson, and two in Venango County, so it is not possible to state accurately its range in this area. However, since it appears restricted in its habitat to cool, moist, rock slides in forests, it probably does not occur in the western counties, but may occur in favorable habitats along the upper Allegheny and Clarion Rivers.

HABITAT. The habitat of this animal appears to be distinctive. Although it was taken in only three localities, the particular niche occupied by *dispar* was the same in all three. In all three places there was little or no soil; instead, just a loose accumulation of rock varying from 2 to approximately 30 feet in depth. Over the loose rock was a mat of leaf mold and tangled roots. All three places were wooded, two of them with mixed hemlock, birches; the other, with hardwoods, mostly chestnut oak and red maple. In altitude the three localities were as follows: 1100 ft., 1200 ft. and 1600 ft. Associated with *dispar* in all of the localities were three other shrews, *Sorex fumeus*, *Sorex cinereus* and *Blarina*, and also present was the red-backed mouse, *Clethrionomys*.

NOTES. The only recognizable food remains in two specimens were parts of centipedes and small spiders.

One female, taken May 3, had 5 embryos less than .5 mm. in length. Of the nine specimens taken in one locality, northern Jefferson County, seven of them were from an area of approximately one acre. In Venango County, only one specimen was taken in each of the two localities.

Specimens taken: 11—Jefferson 9, and Venango 2.

SMOKY SHREW

Sorex fumeus fumeus

DISTRIBUTION. Occurs in all counties although none were taken in two localities on the Lake Plain in Erie County.

HABITAT. Apparently restricted to woodlands and is more abundant near water. In Butler, Beaver and Lawrence counties, this species is more numerous than *Sorex cinereus*. However, in the northern counties, their numbers are more nearly equal.

NOTES. Three stomachs examined contained remains of beetles, beetle larvae, centipedes and spiders.

REPRODUCTIVE DATA

Date	Embryos	Size	Scars	Remarks
Apr. 14, 1947	6	Under 2 mm.		
Apr. 18, 1947	5	Under 1 mm.		
Apr. 20, 1947	6			
Apr. 22, 1947	7	Under 2 mm.		
Apr. 15, 1948				Pregnant
Apr. 16, 1948				Pregnant
Apr. 17, 1948	5	Under 1 mm.		
Apr. 29, 1948	6	Under 5 mm.		
May 5, 1948	2	Under 5 mm.		
June 24, 1948	6	4 mm.		

Specimens taken: 115—Beaver 9, Butler 15, Jefferson 12, Lawrence 12, McKean 2, Mercer 7, Venango 50 and Warren 8.

LEAST SHREW

Cryptotis parva parva

DISTRIBUTION. Our records of this small insectivore in northwestern Pennsylvania consist of specimens collected in two localities in Beaver County and skulls from owl pellets from one locality in Butler County, and one locality in northern Mercer County.

HABITAT. In both localities in Beaver County, the *Cryptotis* were taken in old fields of *Danthonia*; in both, the grass was sparse with small areas of bare ground between the clumps of grass. In one locality, the field was on an exposed wind swept knob, and the other was a floodplain of Little Beaver Creek.

NOTES. This shrew is not common in northwestern Pennsylvania, although probably is generally distributed, at least in the western counties. An indication of its rarity is given in the analysis of owl pellets from this area. In the total number of mammals eaten (2,563) only 9 were of this species. (This does not include the analysis of pellets of the great horned owl.)

Specimens taken: 5—Beaver 5. Skulls from owl pellets: 9—Butler 6 and Mercer 3.

SHORT-TAILED SHREW

Blarina brevicauda brevicauda

DISTRIBUTION. Occurs in all counties.

HABITAT. This is the most uniformly and generally distributed mammal in this section. It occurs in all habitats and whether in a cultivated field or a dense forest it is likely to be the most common mammal present. The nature of the habitat does not effect its distribution but may effect the numbers present.

NOTES. This is the largest of the shrews in Pennsylvania. With its pointed nose and short legs, it superficially resembles a mole, but is readily distinguished by its small mouse-like feet. The true mole

has broad scoop-like forefeet. The food of this shrew is largely comprised of insects and insect larvae, but includes snails, slugs, earthworms, mice and carrion. The economic importance of these shrews as insect destroyers is more easily understood when it is considered that about 25 shrews per acre is near average, and that each of these shrews, weighing about two thirds of an ounce, consumes an amount of food equal to approximately half its own weight every twenty-four hours, and does this twelve months of the year. This would mean that the shrews in a twenty acre field consume, in the course of a year, approximately 3900 pounds of food, the bulk of which is insects, and that in turn, these shrews become food for all predators. *Blarina* is the most abundant single species of mammals in the area. Although it does not reach the great local population that the meadow mouse does, it shows a greater habitat tolerance than any other species, and with few exceptions, is the most abundant mammal in any habitat. Our trapping records indicate that in cold, hemlock forests *Blarina* is less numerous than elsewhere, and in such forests, the number of small shrews, *Sorex* spp., is higher.

Several nests of *Blarina* were examined. Five of them were under boards in open fields; all of them were composed entirely of leaves. Under the boards, at distances of 10 to 20 inches from the nest, there was a portion of the runway used for droppings; the remainder of the runways, and the nest itself, was clean. In one place, a dropping post was observed on the surface of the ground, and from the alternate layers of pine needles in it, it was apparent that this same dropping post had been in use for over two years.

REPRODUCTIVE DATA

Date	Embryos	Size	Scars	Remarks
Aug. 31, 1946	5	18 mm.	*	
Mar. 7, 1947				Not pregnant
Apr. 17, 1947	5	Under 1 mm.		
Apr. 20, 1947	8			
June 13, 1947	5			
June 14, 1947				Lactating; recent birth
Aug. 21, 1947				Lactating
Mar. 4, 1948	3	13 mm.		
Mar. 4, 1948	4	Less than .5 mm.		
Mar. 4, 1948	4	Less than .5 mm.		
Mar. 13, 1948				Early pregnancy
Apr. 13, 1948	4	12 mm.		
Apr. 24, 1948	6	15 mm.		
Apr. 26, 1948	3	15 mm.		
May 12, 1948	3	12 mm.		
May 15, 1948	8	18 mm.		
June 14, 1948				Not pregnant; nursed this spring
Aug. 17, 1948	5	2 mm.		
Aug. 18, 1948	4	8 mm.		
Aug. 18, 1948	5	1 mm.		
Sept. 14, 1948				Not pregnant
Sept. 15, 1948				Not pregnant; parturition recent
Sept. 19, 1948			*	Not pregnant
Sept. 21, 1948				Not pregnant

* Placental scars were not apparent in any of the *Blarina* or other insectivores examined.

Specimens taken: 816—Beaver 82, Butler 110, Erie 198, Jefferson 33, Lawrence 22, McKean 19, Mercer 62, Venango 126, and Warren 164.

BATS

DISTRIBUTION. In the course of our field work we collected specimens of bats of 7 species. Most bats have a wide distribution, and the fact that one was collected in a particular locality is more indicative of local abundance than it is of distribution.

In general, bats are more common in Butler, Beaver, Lawrence, Mercer and Crawford counties than they are in the counties to the east and north. This noticeable increase in numbers in these counties may be accounted for chiefly by the presence of large colonies of *Myotis lucifugus*, the little brown bat, and *Eptesicus fuscus*, the big brown bat. Both these bats roost in buildings, often in large colonies. Large colonies of these were found as follows: 2 in Beaver County, 3 in Mercer County, and 2 in Crawford. Similar large colonies may occur in the counties along the Allegheny River, but certainly not so commonly, since at no place in those counties did we encounter the large numbers of bats that were frequently seen along streams and ponds in the western part of the state.

The red bat, *Lasiurus borealis*, was generally distributed and common in all sections. The silver-haired bat, *Lasionycteris noctivagans*, was taken in but one locality in northern Jefferson County, although it was the most abundant bat seen flying there.

HABITAT. In general, there were recognizable differences in the places the various species chose for feeding. *Myotis lucifugus* was most often found flying low over ponds or streams, usually in large numbers; *Myotis keenii*—only two of these seen in flight. One of these was flying over a small stream, and was the only bat present; the other was flying in a small clearing in the woods. In both cases, the bat was flying an erratic course, back and forth over a small area. Two of the *keenii* collected were picked out of small, lateral crevices in sandstone boulders. The large bats, *Eptesicus* were most common flying at about tree top level along streams or edge of woods. *Lasiurus borealis* were most common along the edge of woods and in orchards. *Lasionycteris* all were seen flying over fields at the edge of woods, rarely more than 2 or 3 at a time.

Specimens taken: Little Brown Bat—*Myotis lucifugus lucifugus*. Total: 66—Beaver 24, Butler 4, Crawford 13, Erie 1, Jefferson 4, McKean 3, Mercer 10, Warren 7.

Trouessart Bat—*Myotis keenii septentrionalis*. Total: 6—Allegheny 3, Jefferson 1, McKean 1, Warren 1.

Silver-Haired Bat—*Lasionycteris noctivagans*. Total: 6—5½ mi. N. E. Sigel, Jefferson County.

Pigmy Bat—*Pipistrellus subflavus subflavus*. Total: 1—Mercer County.

Pigmy Bat—*Pipistrellus subflavus obscurus*. Total: 1—Warren County.

Pigmy Bat—*Pipistrellus s. subflavus x obscurus*. Total: 1—Beaver County.

Big Brown Bat—*Eptesicus fuscus fuscus*. Total: 52—Beaver 1, Butler 17, Mercer 32, Warren 2.

Red Bat—*Lasiurus borealis borealis*. Total: 7—Butler 1, Jefferson 4, Mercer 2.

NON-GAME RODENTS

This is a large and varied group of mammals including such different forms as flying squirrels and porcupines, meadow mice and jumping mice. Their one distinguishing characteristic is the enlarged chisel-like incisors. They are all gnawing animals. The order of Rodents includes species that are valuable as game animals, squirrels and rabbits, some that are valuable as fur bearers, muskrat and beaver, and a few that are notorious as pests, rats and mice.

THIRTEEN-LINED GROUND SQUIRREL or GOPHER

Citellus tridecemlineatus tridecemlineatus

DISTRIBUTION. This ground squirrel is not native to Pennsylvania, but was introduced into this state around 1900 when a pair escaped from captivity in the vicinity of Polk, Venango County. In approximately fifty years they have increased and extended their range until they now occur in scattered colonies in western Venango and northeastern Mercer counties. So far as we can learn they have not crossed any major stream, so that at present their distribution is in an area bounded on the east by the Allegheny River, on the south by Sandy Creek, and on the north by French Creek.

HABITAT. Pasture fields and other short grass areas. They have been reported in cemeteries, church yards, and in the extensive gardens of the State School at Polk.

NOTES. From interviews we learned that they were more abundant in the "thirties" than they are today. In our own observations we noticed a decrease in the spring of 1947 from what they had been the previous fall. It seems that some factor or factors, possibly predation, climate, or both are acting to hold this species in check. In view of the potential importance of this species, both as a crop pest, and as a potential reservoir of plague, the localities where it was reported are listed in detail.

Venango County: Polk—on the grounds of the State School and on nearby farms.

1½ miles S. E. Polk, in Sandy Creek Valley in cemetery.

Niles 1½ miles N. of Polk.

Nicklin Church 3 mile N. E. of Polk.

2 miles S. W. of Franklin at site of airport (3½ miles E. of Polk). This colony probably eliminated by the grading for the airport.

"Bully Hill" 2 miles S. Franklin. This is the most eastern locality from which we have had reports.

"Raymilton Hill" 3 miles W. of Polk, ½ mile S. of U. S. Rt. 62.

Mercer County: 1½ miles N. Sandy Lake along Pa. Rt. 78.

New Lebanon, in town and in churchyard ¾ miles N. E. of town. This locality is 9 miles northwest of Polk and is the farthest from Polk that they have been reported.

1 miles east of New Lebanon where Mercer-Venango County line crosses Pa. Rt. 285.

3½ miles northeast of Sandy Lake on B. H. Cannon Farm.

CHIPMUNK

Tamias striatus

DISTRIBUTION. The chipmunk is a common animal in all counties in this section. In northwestern Pennsylvania two subspecies occur. Those north and east of Mercer County have been identified as *Tamias striatus lysteri*; while those from Butler, Beaver and Lawrence counties are *Tamias striatus fisheri*; the series from western Mercer County appears intermediate between the two forms and was considered by Dr. Doult to represent an intergrading population.

HABITAT. Forest and forest edge. Only rarely do they burrow in fields and then only where there are suitable bushes or logs and rocks for shelter. While often seen around buildings, stone fences, they also occur in dense forests, both coniferous and hardwoods.

NOTES. The food of the chipmunk consists of a wide variety of seeds and nuts supplemented with insects and snails. In late summer and early fall they are busy gathering and storing seeds and nuts; with the coming of cold weather they go into hibernation to remain until late February (in this area). Our observations would indicate that the stores of nuts are used all during spring and early summer. Chipmunks were observed digging up and eating hazelnuts as late as July.

During our stay in Mercer County, June and July, 1947, there was an unusually large hatch of June bugs (*Phyllophaga*) and, during the time they were abundant, their remains were found on all chipmunk feeding places.

Following is a list of the foods chipmunks were observed to eat:

Snails: All of the larger species that occurred in the chipmunks' habitat *i.e.*, all species of *Mesodon*.

Insects: June bugs (*Phyllophaga*), grasshoppers, crickets, katydids.

Nuts: Hickories, both when small and green, and later when ripe, acorns, walnuts, butternut.

Seeds of: Maples, basswood, elderberry, witch-hazel, blackberry, cherries (wild and domestic). Wild crab apple, false Solomon's seal, giant ragweed, trillium, Wild grape, mulberry, crassia, cucumber tree, elm, May apple and wild plum.

Chipmunks come out of hibernation during the last week of February (in Venango County), and go into hibernation in the fall in the last week of October.

The number of chipmunks fluctuates greatly from year to year. With the chipmunks this appears to be a response to local factors since in localities only a few miles apart, chipmunks would be abundant in one and scarce in the other.

REPRODUCTIVE DATA

Date	Embryos	Size	Scars	Remarks
Aug. 15, 1946			5	Plus 3 embryos being resorbed
Aug. 20, 1946			3	
Aug. 31, 1946			3	
Aug. 31, 1946			2	Parturition recent
Mar. 11, 1947				Just bred
July 23, 1947	3	Under 2 mm.		
July 23, 1947	3	Under 2 mm.		
Sept. 9, 1947			6	Recently nursing
Apr. 16, 1948	3	33 mm.		
May 14, 1948			6	Scars faint
May 24, 1948			4	Not lactating
Aug. 21, 1948			5	Not pregnant; not lactating

Specimens taken: *Tamias striatus fisheri* 24—Beaver 10, Butler 14.

Tamias striatus lysteri 59—Erie 7, Jefferson 14, McKean 7, Venango 23 and Warren 8.

Tamias striatus fisheri x *lysteri* 27—Mercer 27.

FLYING SQUIRREL

Glaucomys volans volans

DISTRIBUTION. Occurs in all counties.

HABITAT. Forest and forest edge. This small squirrel finds both the dense forest and small thicket equally suitable.

NOTES. The flying squirrel eats seeds, nuts and insects. How much of their diet is birds and small mammals is not known. When they are numerous they are a nuisance to weasel trappers as they are frequently taken in traps baited with meat. Like other squirrels, they store large quantities of nuts in the fall.

The flying squirrel, even when abundant, is rarely seen since it is entirely nocturnal. Like so many of the small mammals, it may be abundant in some years, then almost disappear in others. During the past two years flying squirrels were found to be common to abundant in three localities, northern Beaver County, northern Jefferson County and Venango County. Elsewhere they appeared to be scarce.

REPRODUCTIVE DATA

Date	Embryos	Size	Scars	Remarks
Oct. 3, 1946			3	Scars indistinct
Mar. 12, 1947				Not pregnant
Mar. 15, 1947	4	Less than 1 mm.		
Mar. 19, 1947	5	7 mm.		
Apr. 17, 1947			3	Parturition recent
Apr. 17, 1947			2	
Apr. 30, 1947				Lactating
May 7, 1947			3	Not lactating

Specimens taken: 25—Beaver 4, Butler 2, Jefferson 8, Mercer 1, Venango 9 and Warren 1.

In addition to the common flying squirrel, the larger northern flying squirrel, *Glaucomys sabrinus macrotis* also occurs in the northern part of this area. Only three specimens of this northern flying squirrel were taken, one at Horse Creek, 6 miles east of Oil City, Venango County, and the other two from Red Mill Brook, 4 miles northeast of Clermont, McKean County.

DEER MOUSE or WHITE-FOOTED MOUSE

Peromyscus leucopus noveboracensis

DISTRIBUTION. All counties.

HABITAT. Forested or bushy areas. Apparently dependent on the presence of woody vegetation for cover but otherwise tolerant of a wide variety of conditions as they live in swamps, cold ravines, brushy fencerows, small thickets or extensive forests.

NOTES. This is one of the three most abundant and widely distributed small mammals in Pennsylvania. It often becomes a nuisance around hunting camps and summer cottages. Although not a permanent resident of open fields, it will move into shocks of grain. An excellent climber, this mouse is equally at home in trees, on cliffs, or running over the rafters of a hunting camp.

Deer mice carry their food to sheltered feeding stations, and in such places there may be large accumulations of seed hulls and insect parts. One constant feature of these feeding stations was that they were all protected from flying predators. They were found under logs or roots, or the edge of a rock and often under a dense tangle of briars or vines. Usually the site selected afforded a good view in several directions at ground level but was concealed from above. As indicated by examination of feeding stations, their food consists of a wide variety of seeds and insects of which the following were most commonly observed:

Black Cherry	Poplar	Hemlock	Sycamore
Maples	Birch	Black Gum	Wild Grape

In Mercer County, June 1947, June bugs (*Phyllophaga*) were frequently eaten, and along the Allegheny River near Kinzua, during July 1948 they were feeding almost entirely on dead crawfish that were washed ashore.

The nest of this mouse is usually placed in some dry place above ground, in a log or hollow tree or fence post. The nest may be constructed of a wide variety of materials but is characteristically lined with some plant or animal fibre, fur, down, wool, cotton, milkweed and thistle-down, etc. These mice will also remodel old bird nests or move into an abandoned squirrel nest.

Deer mice are often hosts to warble fly larvae (*Cuterebra*). During September-October 1948, one series of 69 deer mice from near North East, Erie County, was examined in which 33 were free of warbles, and 36 of the specimens had 1 to 3 larvae. The larvae were most frequently in the skin of the groin, and occasionally elsewhere on the venter. Two different species of *Cuterebra* were present, sometimes on one mouse. At present, these have not been identified.

CLOUDLAND DEER MOUSE

Peromyscus maniculatus nubiterrae

DISTRIBUTION. Cold damp forests of the high plateau section and westward in cold swamps.

HABITAT. The birch-hemlock forests of the higher parts of the Appalachian plateau and in cold swamps westward.

NOTES. This mouse is apparently local in distribution in northwest Pennsylvania and does not occur in many habitats that appear suitable.

Its food habits are apparently similar to those of the common deer mouse, *Peromyscus leucopus*. In one locality where we were able to get definite information on this species hemlock seeds were the only observed food item. In northern Jefferson County both this species and the common deer mouse occurred together, and both were scarce. One locality, 5½ mi. northeast Sigel, that was trapped from April 15 to May 10, 1948, approximately 2000 trap nights, yielded 7 *Peromyscus leucopus* and 10 *Peromyscus maniculatus nubiterrae*.

With this scarcity was what appeared to be a difference in habitat preference between the two species. The area was densely wooded with hemlock and black and yellow birch and had numerous large blocks of massive sandstone and sandstone ledges. All of the *nubiterrae* were taken in traps set on miniature ledges of the sandstone blocks and outcrops, while the *leucopus* were all taken in traps set on the ground or in runways through the leaf mold. This was not observed in any other locality; in fact, elsewhere the two species were commonly taken both on ledges and on the ground. Since this behavior was associated with a low population density, it may represent a change in the animals' habit pattern in response to unfavorable environmental conditions.

Specimens of *Peromyscus maniculatus nubiterrae* were taken in the following localities:

Jefferson County—5½ miles northeast Sigel; 8 miles northeast Sigel.

McKean County—Sugar Run, 10 miles southwest Bradford; Red Mill Brook, 4 miles northeast Clermont.

Warren County—Benson Swamp, 5 miles east Columbus. 2½ miles north Kinzua.

PRAIRIE DEER MOUSE

Peromyscus maniculatus bairdii

DISTRIBUTION. Locally common in all of the western counties, and east to the Allegheny River. The original range of the prairie deer mouse in Pennsylvania was probably restricted to the Erie Lake Plain and the Ohio Valley, but with the clearing of the forests the amount of available grassland habitat was greatly increased and this small mouse has been able to extend its range eastward.

HABITAT. Open fields and grasslands. In this area it seems to prefer places with sparse vegetation, weedy road cuts and fills, beaches, sandy ridges, etc. It was more numerous on the Lake Erie Plain, Erie

County, and in the Ohio Valley in Beaver County although it was not abundant in any locality trapped.

NOTES. Its food is comprised of grass and weed seeds, sweet clover seed, corn, small grain and soy beans. In late summer they feed extensively on crickets, grasshoppers and ground beetles. All of the nests seen were under boards or other debris in fields except for one that was a meadow mouse nest that the deer mouse had remodelled by lining it with milkweed down.

In the series identified by Dr. Doult as *bairdii* there is included a group of mice that is of interest. Although they have many of the morphological characters of *bairdii*, they have distinctive habitat preferences. In life they appear as small, dull colored *leucopus*, intermediate in size and proportions between *leucopus* and *bairdii*, but when prepared as conventional museum skins they are less distinctive in appearance. The skull, in size and proportions, resembles that of *bairdii* more than it does either *leucopus* or *nubiterrae*.

In their habitat preference they appear to be restricted to low lying forests and brushy areas and were most abundant in the floodplain thickets of alder, willows and crabapple. In the summer these thickets with their rank growth of weeds and vines make an almost impenetrable tangle quite unlike the short grass or sparsely vegetated areas preferred by the prairie deer mouse. These mice were common along the Allegheny River and smaller streams in Venango County in 1947 and 1948, and were especially numerous along the Allegheny River in eastern Warren County in 1948 although other *Peromyscus* were generally low in numbers throughout northwestern Pennsylvania in these years.

With the additional specimens and data being obtained in the southwest and central portions of the state, it should be possible to determine the affinities of this form.

Data on litter size and breeding seasons was obtained for the various forms of *Peromyscus* but is not included here, pending identification of all the specimens.

Specimens taken: A total of 908 *Peromyscus* were taken. The identification of all of these is not as yet completed, but the series includes approximately 600 *leucopus*, 200 *bairdii*, and 40 *nubiterrae*.

CLIFF RAT

Neotoma magister

DISTRIBUTION. The Allegheny cliff rat, although common in the central and southwestern counties, was not previously known from northwest Pennsylvania. It is apparently not widely distributed in this section, and so far, has been found only in Venango County. In view of its peculiar distribution, a detailed list of the localities where it was observed is given at the end of the notes.

HABITAT. In this section there are no caves, and this rat is apparently restricted to cliffs and ledges of sandstone and the rocky slopes below them.

NOTES. This interesting large rat is related to the pack rats or trade rats of the western mountains, and like them has the same habit of carrying all kind of miscellany back to its nest. Their presence around a cliff is easily recognized by the large piles of sticks and trash dragged onto a sheltered ledge or back in a large crevice. These piles are usually several feet across and contain two or more bushels of sticks, leaves, old bones, feathers, and where they have access to a refuse heap, or dump, they carry into a nest pile almost any bit of trash that they can move. The colony observed near Kennerdell, where they had access to a large dump, had piled up with their usual assortment of sticks, dish rags, bottle caps, pieces of rope, paper, lemon peels, small boxes, and in general all sorts of portable rubbish. With this habit of dragging in anything that attracts their curiosity, it is not always possible to determine what of this accumulation is stored food stuffs.

For example: One large nest, or midden, that was examined contained almost a bushel of dried fungi. The bulk of these were one or more species of *Russula* which are a brilliant red. All of these were entire, and there were no scraps indicating that any had been eaten. In other middens there were pieces of leafy stems of wild grape, willow, asters and *Baptisia*. In one locality they had been cutting rhododendron twigs, apparently eating only the bark and discarding the leaves and flower buds.

A number of cliffs were examined for evidences of cliff rats and they were found on the following: On the cliffs that form the rim on the east side of the Allegheny gorge, near Kennerdell; State Game Lands No. 39, 6 miles southwest of Franklin; on knob south of and overlooking Polk; 1 mile southwest of Utica.

Other rock outcrops that appeared to offer suitable habitat were examined without finding any evidence of cliff rats. These were: Cliffs above Hemlock Creek $2\frac{1}{2}$ miles southeast of President, Venango County; Nuttle's Rocks, 2 miles south of Kinzua, Warren County, and Beartown Rocks, near Clear Creek State Park, Jefferson County.

District Game Protector William J. Carpenter, of Mt. Jewett, told us that he does not believe that cliff rats occur in McKean or eastern Warren County as he is familiar with most of the ledges and cliffs in those counties and has never seen any sign of these rats.

Specimens taken: 9—Venango 9.

MICROTINE RODENTS OR VOLES

This group is represented in northwest Pennsylvania by four different forms, of which the common meadow mouse (*Microtus*) is the most numerous and widespread, and the best known. The other three are superficially similar to the meadow mouse in size and appearance and are the red-backed mouse (*Clethrionomys*), the pine mouse (*Pitymys*) and the lemming mouse (*Synaptomys*).

As a group they occupy all habitats; they are all forms that show periods of great abundance followed by periods of scarcity. They feed almost entirely on plants, and as a group, form one of the most important

links between plants and carnivores. It is difficult to over-estimate the economic importance of this group since it includes two of the most destructive rodent enemies of agriculture, the meadow mouse and the pine mouse.

Since the presence of a groove on the face of the upper incisors is one of the characters used to distinguish skulls of *Synaptomys* from those of other members of this group, it is interesting to note that in northwest Pennsylvania both *Clethrionomys* and *Microtus* show a tendency to have grooved incisors. This is especially true of *Clethrionomys*; over half of those examined have a faint groove on each incisor.

LEMMING MOUSE

Synaptomys cooperi stonei

DISTRIBUTION. Probably in all counties.

HABITAT. This species does not appear to be restricted to any easily defined habitat. It was not observed or taken in any marsh, swamp, or bog habitats. It was taken most often in old fields grown up in *Danthonia*, in thickets, and in grassy clearings in forests. It is possible that this mouse was originally restricted to the more open forests and forest edge.

NOTES. In those localities where both *Microtus* and *Synaptomys* occurred, they appeared to be occupying different portions of the field or other habitat. Only rarely did we find them using the same runways. This segregation of the colonies was not determined by minor variations in the habitat, nor was it constant as the same area that at one time would be occupied by *Synaptomys* might later contain only *Microtus*.

The following list of plants eaten are arranged in order of frequency of observations and shows the part of the plant eaten and the time of the year.

Danthonia (Poverty Grass)—Basal portions of leaves, October to May. Seed heads, July, August and September.

Timothy seed heads, July and August.

Sedges, seed heads, July and August.

Poa pratensis (Blue Grass)—Stems and leaves, May to November.

Poa compressa (Canada Blue Grass)—Basal stems and leaves, May to November.

Lycopodium complanatum (Ground Pine)—All green portions eaten during the winter. Ripe heads, September and October.

In addition to these, ferns of the genus *Aspidium* and various mosses and liverworts, including *Conocephalum* and *Marchantia*, were observed as being eaten.

One nest containing 2 young was found in a shallow depression and it was indistinguishable from the nest of the meadow mouse. The apparent scarcity of nests in places where *Synaptomys* was common probably indicates that they construct most of their nests underground.

Synaptomys characteristically pulls grasses and other foodstuffs into its runways and burrows so that the runways are usually littered with cut and uncut pieces of grass in contrast to the clean runways of the common meadow mouse. The runways are narrower than those made by the *Microtus* and are usually $\frac{3}{4}$ to 1 inch in width, while those of *Microtus* are usually over an inch in width. Unlike *Microtus* their surface runways open into underground runways every few feet.

Wherever these mice were taken, they appeared to be present in the locality in small, more or less definite colonies, and not generally distributed, even in favorable habitats. *Synaptomys* colonies are sufficiently distinctive that the presence or absence of this species in a locality is most easily determined by looking for their characteristic sign. While many colonies were trapped with negative results, 51 of the 53 *Synaptomys* taken were trapped in previously recognized colonies that had been located by inspection and only 2 were taken in lines of traps set at random.

Unlike *Microtus* and *Pitymys*, this rodent is not on record as a pest.

REPRODUCTIVE DATA

Date	Embryos	Size	Scars	Remarks
Aug. 25, 1946	2	12 mm.		
Aug. 31, 1946			3	Recent scars
Oct. 4, 1946	3	17 mm.		
Oct. 17, 1946	1	5.5 mm.		Just past lactation
July 19, 1947			3	
July 1, 1948	3	8 mm.		One embryo being resorbed

Specimens taken: 53—Beaver 12, Butler 23, Lawrence 3, Mercer 8, Venango 4 and Warren 3.

RED-BACKED MOUSE

Clethrionomys gapperi paludicola

DISTRIBUTION. Apparently in all counties except Armstrong, Butler, Beaver, Lawrence and Mercer.

HABITAT. Forests. Not restricted to any one type of forest although more abundant in the northern beech-birch-maple forests, especially where there are hemlocks. It is of interest that in what appeared to be suitable habitat in Beaver, western Mercer and Lawrence counties none of these mice were taken, although the deep ravines in these counties are cool and rocky and are wooded with black and yellow birch and hemlock. In fact, no species of mammal was found in them that did not occur in other wooded areas in those sections. In this section the distribution of the red-backed mouse is subject to some factor other than the occurrence of a particular forest type. Northward it is more general in its distribution.

NOTES. In the counties of the high plateaus section the red-backed mouse is common and generally distributed in forests. Although small favorable habitats often carried high populations in marked contrast to nearby areas, this appears to be merely local variations in population densities rather than an indication that this mouse occurs in iso-

lated colonies. However, west of the forested areas, suitable habitat, *i.e.*, forests, become discontinuous as the result of agriculture and present colonies of this mouse on the border of its range are restricted to isolated large swamps and rocky ravines.

The red-backed mouse in the two winters of 1946 and 1947 was abundant in the woods around Franklin, Venango County, and the following plants were observed to be important winter food.

Ferns: All of the evergreen ferns were eaten, although the shield fern (*Dryopteris*) and the common Polypody seemed to be preferred. In addition to these, numerous mosses were eaten as well as birch and hemlock seeds.

REPRODUCTIVE DATA

Date	Embryos	Size	Scars	Remarks
Feb. 10, 1947			3	Old scars
Apr. 24, 1947			4	
Aug. 15, 1947	4	Small		
Mar. 23, 1948			6	Old scars
Mar. 23, 1948			3	Old scars
Apr. 6, 1948	4	Under 1 mm.	5	
Mar. 18, 1948			6	
Apr. 23, 1948			4	Recent birth
Apr. 24, 1948	7	Under 1 mm.		
May 5, 1948			4	Recent birth
May 10, 1948	5	5 mm.		
May 23, 1948			7	Not lactating
May 25, 1948			5	Not lactating
June 20, 1948			2	
June 26, 1948	4	20 mm.		Not first litter
Sept. 10, 1948			5	Not lactating
Sept. 10, 1948			4	Not lactating

Specimens taken: 189—Erie 3, Jefferson 22, McKean 15, Venango 124 and Warren 25.

MEADOW MOUSE

Microtus pennsylvanicus pennsylvanicus

DISTRIBUTION. Generally distributed in all counties of this section.

HABITAT. Fields or any area where there is grass. Occasionally found in wooded areas but this seems to be a temporary condition, probably correlated with high numbers.

NOTES. This small rodent is equalled in economic importance only by the Norway rat, and with the rat, has received more attention and study than any other small mammal.

Its principal claim to fame is its almost unbelievable fecundity. Its rate of increase is higher than that of any other mammal in our area. From late March until November one litter follows another approximately every five weeks; each litter may have 3 to 8 young, and the young females are ready to breed when only three weeks old. (Hamilton 1943.) The periodic fluctuations in the numbers of meadow mice has long been the subject of much study, both in this country and in Europe. In our work we found that there were some local populations that appeared to be at, or near their peak density, while within 20 or 30 miles, they

were scarce. One of the most striking examples of this was observed in July and August 1948 when an unusually high population was present in the Allegheny Valley, near Kinzua, eastern Warren County, while 30 miles to the east, along Red Mill Brook, eastern McKean County, meadow mice were scarce.

Most sampling methods assume that the species being sampled is uniformly or randomly distributed in favorable habitats. However, in trying to work out techniques for measuring *Microtus* populations, we found that even in a more or less uniform habitat, such as a meadow, the mice were not uniformly distributed. This was most noticeable with low populations, as then the *Microtus* would be localized into more or less definite colonies in a field. This was first noticed in Beaver County in the spring of 1947 and after that, we noticed that it was generally true. However, in the Allegheny Valley, near Kinzua, in the summer of 1948, *Microtus* were abundant, and appeared to be uniformly distributed in favorable habitats. In most instances, there was an apparent correlation of these small colonies with some minor variation in the habitat such as a moist spot in the field, or a small patch of denser grass. These scattered small colonies may represent a response to minor habitat variations, or possibly represent an effort on the part of the mice to maintain a favorable population density in the face of declining numbers.

The summer food of *Microtus* is succulent vegetation of almost any kind. From mid-summer on, the meadow mouse feeds on the ripe seeds of various grasses. Since most of these, like timothy, are well out of reach of the mouse, it obtains them by cutting the whole plant down and neatly cutting it up into short lengths until the head is reached. In the winter it feeds on the bark of shrubby plants and trees, in addition to perennial grasses that remain green all winter. In this area the most commonly barked plants were apple, black cherry and blackberry.

In addition to all of the common hay and pasture grasses the following plants were observed as important foods in one or more localities: Poverty grass (*Danthonia spicata*), both the basal leaves and seeds are eaten; ground pine (*Lycopodium complanatum*) the nearly ripe heads were eaten.

On two occasions caches of tubers were found that were attributed to this species. One of these consisted entirely of *Helianthus* tubers and the other was composed of underground stems of *Convolvulus* sp. and tubers of *Helianthus*. A third cache was seen that may have been the work of either this species or *Pitymys*. It consisted entirely of the underground stems of wintergreen (*Gaultheria*).

Where the meadow mouse occurs in numbers it may be very destructive to orchards, small fruit plantings and nursery stock. However, apart from the damage *Microtus* do to agriculture, which at times may be serious, it is also useful in that it is the principal prey species for many of our predators.

Approximately two hundred nests of *Microtus* were examined in order to obtain information on ectoparasites, reproduction and storage of food. All of these that were being used by *Microtus* were uniform in that the lining of the nests was always composed of finely-shredded grass or sedges. None was lined with plant fibres such as milkweed, etc., and the bulk of the nests was made of a wide variety of grasses, sedges or

rushes depending on what was available. The top layer or covering of the nest was interesting in that it was composed of the same material as covered the ground in its vicinity. Where the ground was covered with dry dead grass, the nest had no additional covering, but the nests observed during the summer had a layer of leaves, pieces of green moss, or fine broken plant stems on the top of it so that they blended into their background. Our observations indicate there is a peak in nest building in late November and early December, and at that time the nests tend to be grouped. In one large meadow we examined in late November, approximately fifty nests were found. These were distributed in five groups of five to a dozen nests each. Four of these groups consisted of nests on the surface of the ground, and in each group, the nests ranged from 8 inches to 6 feet apart. One group of nests in a bank at the edge of the field were all below ground, usually at a depth of 2-4 inches at the end of a short burrow. The basis for selecting the sites where the nests were grouped was not apparent. None of the nests examined in Beaver County in November, 1947, contained young, although young were found in surface nests during November, 1947, in Erie County. Apparently, underground nests are constructed in the spring and used for the first litter of young; then as the rank vegetation of the summer affords sufficient cover, surface nests are used for raising young. There was no evidence of food being stored in the nest. Most of the nests examined were literally crawling with immature ticks, fleas, and flea larvae, and occasional specimens of the nest beetles (Leptinidae). *Microtus* nests were often found that had been abandoned and were being used by other mammals and insects. *Peromyscus maniculatus bairdii* were taken in what appeared to be old *Microtus* nests that had been made over by adding a lining of milkweed and thistledown. A few nests were found that had been lined with entire leaves, apparently the work of some shrew. Several of the nests examined were occupied by ant colonies, but strangely, in the summers of 1946, '47, '48 only two nests were found occupied by bumblebees.

Reproductive data was obtained from 86 specimens. The earliest date of litters noted was in early April, 1947, in Beaver County. Young, old enough to leave the nest were taken April 17. Breeding stopped in October, 1946, in Beaver County as the date of the last pregnant specimen examined was October 20 although specimens were examined through November. In 1947 breeding continued a few weeks later. Pregnant specimens were collected as late as November 8 and nests with young were found as late as November 15. The average number in a litter each of the three summers was 5.

Specimens taken: 696—Beaver 154, Butler 94, Clarion 7, Erie 167, Jefferson 26, McKean 5, Mercer 23, Venango 81 and Warren 139.

PINE MOUSE

Pitymys pinetorum scalopsoides

DISTRIBUTION. Probably occurs in all counties.

HABITAT. It appears to be restricted to sandy or friable loamy soils and in northwest Pennsylvania is a species of the forest and forest edge.

NOTES. During the summer of 1946 *Pitymys* was common in woods and thickets of Butler and Beaver counties, but during the summers of 1947 and 1948 it was very scarce throughout the whole of the area so most of our observations on food and habitat preference apply to Butler and Beaver counties. In those two counties they were most abundant on colluvial soils below sandstone ledges. In such places they were associated with such plants as black walnut, black cherry, basswood and wild grape, usually with a dense undergrowth of blackberry, bluegrass, violets and ground ivy (*Nepeta*). *Pitymys* were observed to feed on violet root stocks, stems and leaves of stone crop (*Sedum*), wintergreen, (*Gaultheria*). Since this mouse obtains more of its food underground than does the meadow mouse, evidences of its feeding are less frequently seen. However, it is known to be primarily a root feeder, and in orchard sections in Virginia and elsewhere is a serious pest (Hamilton 1943). During the winter months it may completely remove the bark from the roots of apples and other fruit trees. This is all the more serious since the damage is usually not discovered until the tree is dying. Although this species is potentially a serious pest we did not find it occurring anywhere in cultivated areas, and in most places it was present in very low numbers.

REPRODUCTIVE DATA

Date	Embryos	Size	Scars	Remarks
Aug. 27, 1946	3	5 mm.		
Aug. 29, 1946	2	18 mm.		
Aug. 29, 1946	1	20 mm.		
Aug. 31, 1946	2	20 mm.		
Aug. 31, 1946			2	
Sept. 30, 1946			2	
Oct. 2, 1946			2	Lactating; scars old
Oct. 7, 1946	1	24 mm.		
Oct. 12, 1946			3	Very recent scars
Nov. 2, 1946			2	
Sept. 8, 1947			2	Lactating

Specimens taken: 44—Beaver 20, Butler 11, Lawrence 2, Mercer 1, Venango 8 and Warren 2.

HOUSE MOUSE

Mus musculus musculus

DISTRIBUTION. In all counties.

HABITAT. Buildings. In some years these mice are common in woods and fields, and at such times show no marked habitat preference. They were taken in grain fields, shocked corn, hay meadows, cold swamps, birch forest.

NOTES. The common house mouse was taken in woods up to one mile from the nearest house. The only places we found them to be common in fields were near the buildings. In abandoned buildings and camps that are occupied for but a few weeks out of the year, the house mouse rarely occurs. In such places, it is the deer mouse that moves in.

In general, the house mouse seems more dependent on man for its food and shelter than the Norway rat.

Specimens taken: 37—Beaver 7, Butler 1, Crawford 3, Erie 8, Mercer 11 and Warren 7.

NORWAY RAT

Rattus norvegicus

DISTRIBUTION. In all counties.

HABITAT. The principal habitat of this rat is anywhere that it is associated with man. Although originally a native of Europe, it has traveled with man until now it is worldwide in its distribution. In our field-work we made an effort to determine to what extent the Norway rat was living apart from man where it would be competing with, or associating with, our native animals. With the exception of corn fields near farm buildings and large rubbish dumps anywhere, the feral rats we found were all living along streams. Large populations of rats were observed along the Ohio River and Little Beaver Creek in Beaver County and along the Allegheny River in Venango and Warren Counties. In August 1948 their tracks were common along Red Mill Brook and the east branch of Toby Creek near Clermont in McKean County, and along small tributaries of these streams.

NOTES. Those that were living along the larger streams appeared to be feeding partly on the plants growing there, and partly on whatever garbage drifted along the shore. Near Kinzua, they were feeding on crawfish. In eastern McKean County they were living along small, cold trout streams, and we were unable to discover on what they were feeding. What the relationship of the feral Norway rat is to the other animals is a question on which we obtained no information but from what is known of the rat's behavior on a farm, they are probably a serious predator. On farms they are notorious for their egg eating as well as for their ability to kill baby chicks and ducklings. We did observe that rats would rob entire lines of mouse traps or come in to meat baited weasel traps. Unlike our native predators which at the worst, produce fur, no good can be said for this animal.

Specimens taken: 24—Beaver 8, Butler 2, Erie 1, Jefferson 1, McKean 3, Venango 4 and Warren 5.

MEADOW JUMPING MOUSE

Zapus hudsonius hudsonius

DISTRIBUTION. Occurs in all counties.

HABITAT. Primarily a grassland form but also occurs in weedy thickets along streams.

NOTES. The jumping mouse apparently feeds almost entirely on seeds, and ordinarily examinations of their stomachs shows only a mass of starchy substance. We have seen them feeding on ripe heads of timothy, wild strawberry and on two occasions they were observed climbing tall plants of dock (*Rumex* sp.) and feeding on the almost ripe seeds.

These small mice were abundant in Butler, Warren and Erie Counties and were scarce in Beaver, Mercer and McKean Counties.

The earliest date that *Zapus* were trapped was May 16, 1947, June 16, 1948 and the latest dates were Oct. 26, 1946, Nov. 15, 1947.

In 1947 a few were still active in three inches of snow on November 9.

REPRODUCTIVE DATA

Date	Embryos	Size	Scars	Remarks
Aug. 26, 1946			4	
June 30, 1947			5	Lactating
June 18, 1948			6	Lactating

Specimens taken: 104—Beaver 6, Butler 42, Erie 15, Lawrence 1, Mercer 9 and Warren 31.

WOODLAND JUMPING MOUSE

Napaeozapus insignis insignis

DISTRIBUTION. Occurs in all counties.

HABITAT. Forests. While apparently not restricted to wet areas, they are more abundant in the vicinity of small streams or wet places in the woods. In the eastern counties of this section *Napaeozapus* is generally distributed in wooded areas; in the western counties it appears to be restricted and local, and was found only in cool swamps or ravines. Specimens were taken on the Ohio state line in extreme southwest Beaver County (Bieler's Run). Nowhere was it observed to occur in as large numbers as the meadow jumping mouse.

Like the meadow jumping mouse they hibernate rather early in the fall and they are one of the last to emerge in the spring. The earliest date *Napaeozapus* was trapped was May 1, 1947 and May 29, 1948; the latest date was October 25, 1946.

REPRODUCTIVE DATA

Date	Embryos	Size	Scars	Remarks
Aug. 29, 1946			5	Scars very faint
Aug. 31, 1946			5	
May 5, 1947			4	
May 30, 1948	6			
May 30, 1948	5			
June 1, 1948	5	7-10 mm.		
June 1, 1948	4			
Sept. 15, 1948			2	

Specimens taken: 55—Beaver 3, Butler 13, Erie 3, Jefferson 12, McKean 8, Mercer 2, Venango 8 and Warren 6.

PORCUPINE

Erethizon dorsatum dorsatum

DISTRIBUTION. Generally distributed in McKean, Warren, Elk Forest and Venango Counties, and common in northern Jefferson, northern Clarion, extreme southeastern Erie County and eastern Crawford County.

HABITAT. The porcupine is restricted to forests and, although not a necessary habitat factor, cliffs and rocky slopes are an important factor in enabling the porcupine to exist in areas close to man.

NOTES. During the summer months they feed on a wide variety of plants, but during the winter they feed almost entirely on the inner bark of trees. They feed on a wide variety of trees although in any one locality, some one species may be preferred. The trees most often barked are white pine, pitch pine, hemlock, black cherry, maples and aspen. During April and May, porcupines were often seen feeding on grasses and other herbaceous plants on road shoulders; but as soon as the trees and shrubs of the forest came into leaf, their appearance on roadsides stopped. Today man appears to be the only enemy of the porcupine that affects its distribution and numbers, so in sections where they are not molested, these animals have increased to where they are a nuisance. Almost any hunting camp or unoccupied farm building in Warren, McKean, Forest and Elk Counties illustrates the gnawing abilities of the porcupine and its tendency to gnaw on anything.

Of all animals examined, porcupines were the most thoroughly and completely parasitized. The identification of the parasites has not been completed. Noteworthy among our findings, however, is the record of mange on porcupines. The mange mites were collected and at present are being identified. Mange was observed on porcupines in two widely separated localities:

near Pleasantville, Venango County	1
5½ mi. N. E. Sigel, Jefferson County	3

Five females from northern Jefferson County examined between April 17 and May 1, 1948, were pregnant. Apparently in this section, the young are born in May.

Specimens taken: 31—Forest 2, Jefferson 16, Lawrence 1, McKean 2, Venango 6, Warren 4.

CHANGES IN MAMMAL POPULATIONS

The known periods of abundance of mammals are approximately ten years from peak to peak for such forms as the snowshoe hare, and three to four years for the small rodents such as the meadow mouse. In two and one-half years of field work it was not possible to follow any one species through its complete cycle of scarcity and abundance. However, during this time we observed that some forms appeared to be increasing and that others appeared to be decreasing in numbers. In addition to our own observations, through interviews and records we were able to learn of recent changes in the relative numbers of fur-bearers. With some species, particularly squirrels and rabbits, local and seasonal fluctuations in numbers were so great as to obscure any general trend. A summary of our information by species follows:

FUR-BEARERS

RACCOON—Generally abundant. They have been increasing in recent years, and are at, or near, a high at present in northwest Pennsylvania.

In the season of 1946-47 the regulations concerning hunting and trapping were changed to permit a higher take of raccoon, but this liberalizing of the seasons and bag limits for the past three years has been, in part, offset by the very low price for pelts.

MUSKRAT—Unusually low in 1946-47 and 1947-48 but up considerably in the winter of 1948-49, apparently as the direct result of favorable weather during the summer and fall of 1948.

SKUNK—The data for skunks is meagre but shows that an abrupt drop occurred in 1942 in Beaver and Butler Counties and in 1944 in Crawford County when their numbers were greatly reduced by disease.

According to trappers and fur-buyers, this drop in the number of skunks was first apparent in southern Ohio and spread north and east. East of the Allegheny River their numbers at present appear to be normal to locally high, with the highest population observed in northeast Warren County; in the counties west of the river, particularly in southern Butler and northern Beaver Counties, their population is still low, but is apparently increasing. This increase is not reflected, however, in the number sold as the prevailing low price discourages trapping for skunks or skinning those that are caught in other sets.

FOXES—Red and gray foxes are generally abundant and although they have been at all time peak of abundance since 1945, they appear to be decreasing slightly. (See Notes under Foxes.)

MINK—Mink have been increasing in recent years. They are now abundant and are either increasing or remaining stationary.

WEASELS—Although weasels are relatively common in all areas except Beaver County, they are scarcer than they were in 1936 when over 3,000 were offered for bounty from Crawford County alone as compared to 477 in the fiscal year 1947-48. (See Notes under New York Weasel or Common Weasel.)

GAME ANIMALS

SNOWSHOE HARES—Snowshoes are not abundant, but after reaching a low in 1945, they have been slowly increasing.

RABBITS AND SQUIRRELS—No evidence of a general change was observed in these two game animals. They seemed to be abundant in some localities and scarce in others in each of the three summers.

RED SQUIRRELS—Red squirrels are very scarce in Beaver County and in Western Mercer County although hunters told us that up to ten years ago they had been numerous. They do not seem to be declining generally as they are common to abundant in Venango County and in the counties north and east of Venango.

SMALL MAMMALS

GROUND SQUIRREL—*Citellus* was scarcer in the summer of 1917 than it had been in 1946, and this form was still scarce in 1948. According to people interviewed, the "gophers" had been most abundant in the "thirties" and are much scarcer now.

CHIPMUNKS—Locally abundant. No noticeable general change in their numbers.

FLYING SQUIRRELS—*Glaucomys* was generally scarce. Only one locality was found where they were abundant and that was on the high plateau in northern Jefferson County.

MEADOW MOUSE—*Microtus* was generally more scarce in 1947 than in 1946, and still scarcer in 1948. Several exceptions to this apparently general trend were observed: the Erie Lake Plain had numerous meadow mice in November of 1947 and October 1948, and the Allegheny Valley, above Warren, had abundant populations in July 1948 although on the Allegheny Plateau, within ten miles of the valley, *Microtus* were scarce.

LEMMING MOUSE—*Synaptomys* were apparently more scarce in July 1946 than they had been earlier that summer, and much scarcer in the summer of 1947 than they had been in '46.

DEER MOUSE—*Peromyscus* were common to abundant in northern Beaver County in October 1946, in the Allegheny Valley, Venango County during the winters of 1946-47 and 1947-48, in the Allegheny Valley, Warren County in July 1948 and on the Erie Lake Plain in October 1947 and October 1948. They were scarce in Butler County in July 1946, in Mercer and Lawrence County, July 1947, western Warren County, September 1947, in northern Jefferson County, April 1948 and in eastern McKean County in August 1948. No explanation for these local variations was apparent.

CLIFF RAT—On the basis of nests and middens, *Neotoma* was less numerous in this area in September 1948 than it had been the previous fall.

ECTOPARASITES

Most of the mammals collected, both game and non-game species, were infested with fleas, lice, ticks and mites. In view of the increasing interest in insect and tick-borne diseases, both of man and game animals, it was considered desirable to preserve these for future study. Techniques were devised for collecting, with a minimum expenditure of time in the field, all ectoparasites occurring on the mammals obtained. All such specimens were turned over to a cooperating agency for identification and study, and the findings will be available as these studies are completed.

Since our methods for collecting ectoparasites were developed to meet the needs of field workers who wish to preserve such specimens with a minimum of time and equipment, they are described here in detail in the hope that they may be of use to others who have this problem. These procedures were developed with the assistance of Dr. George E. Wallace, Section of Entomology, Carnegie Museum, Pittsburgh, Pa.

When animals were collected they were placed in separate paper bags. For the small mammals, ordinary waxed sandwich bags were used, and for the larger animals, waxed garbage bags proved satisfactory. Both of these are easily obtained. A small amount of paradichlorobenzene crystals was put in the bag with the mammal. In approximately twenty minutes the mammal was removed, leaving ticks and fleas in the paper bag. The bag was then given a catalogue number and sent to the Section

of Entomology, Carnegie Museum, where the parasites were removed and transferred to alcohol for preservation and study.

It has been our experience that this procedure permits the recovery of most of the fleas and ticks, and some of the lice, but very few mites. When it was desired to obtain a higher recovery of lice and mites, the mammal, after it was removed from the paper bag, was brushed over a piece of plain paper, and the brushings were placed in a vial of alcohol. This vial was then given the same number as the paper bag so that both lots were identified as coming from the same host. These brushings have been found to contain small lice, mites and the early microscopic stages of ticks that would not otherwise be collected in the field without special equipment.

For larger animals (rabbit and larger) we found that if the animal was skinned, and then with fur side out, had paradichlorobenzene dusted into the fur and was rolled up for approximately twenty minutes, lice and seed ticks could be brushed out of the fur.

We noticed in the fur sheds we visited that whenever a cold animal was brought into a warm room seed ticks and fur mites would migrate out to the tips of the hairs. We took advantage of this habit by brushing such animals thoroughly over a newspaper. The resulting collection of fine debris and parasites was then brushed into a sandwich bag and the bag labeled. Later the contents of the bags were transferred to vials of alcohol and properly labeled. Where the parasite had caused damage to all or part of the pelt, this was noted.

To collect mange mites (*Sarcoptes*) from dried pelts or dead animals the following method proved to be most satisfactory for field work since it too required a minimum of equipment and permitted recovery of mites from both dried pelts and fresh specimens. Mangey portions of the pelt were removed and pinned out to dry. When they were thoroughly dry, they were stored in waxed paper sandwich bags together with the necessary data.

To obtain the mites from these specimens or from fresh material, small strips or pieces one to two inches long were cut from the sample, placed in a quart jar or wide mouthed bottle of water to which one tablespoonful of Dreft* had been added, and soaked until the skin was soft. Sometimes this was several hours or overnight in the case of thick, hard specimens. After the skin was softened, the infected areas were scraped and shaken thoroughly to remove all loose material. The pieces of skin were removed and the suspended material in the water permitted to settle. The dirty water was decanted off and clean water added. The first settling takes longer as the water is usually quite dirty and the mites settle slowly, but in the second or third washings, the mites and fine particles of dirt settle out more rapidly.

If it is desired, the sediment can be examined immediately with a microscope and the mites removed or the sediment can be preserved in alcohol or formalin and the mites removed later.

But using this method large numbers of *Sarcoptes scabiei* were recovered from a fox pelt (*Vulpes*) that had been poorly dried, and was at least a year old at the time it was examined.

* Other detergents should work as well or better but Dreft was found to be the most satisfactory of those that are generally available.

In addition to these techniques, we assisted Dr. George Wharton in testing a new technique developed at Duke University for collecting and shipping live chiggers. This technique is described in detail by Charles E. Farrell and G. W. Wharton, "A Successful Method for Shipping Larval Trombiculids (Chiggers)", THE JOURNAL OF PARASITOLOGY, February 1948, Vol. 34, No. 1.

All of the material as collected was sent to the division of Entomology at Carnegie Museum, Pittsburgh. There it has been sorted, labeled and sent out to various specialists for identification. According to Dr. Wallace, this material includes approximately 2,000 fleas, 4,000 lice (Anoplura and Mallophaga) 200 adult ticks, 100 *Cuterebra* larvae and innumerable mites and immature ticks. Getting this volume of material sorted and identified is a slow process, but Dr. Wallace reports that all of this material is now sorted and has been sent to the various people who are identifying them.

The following table shows the number of mammals from which ectoparasites were obtained. Forty-one species of mammals are represented including two species of moles, three of *Sorex*, four of bats, three of weasels, two of squirrels, two flying squirrels and three species of *Peromyscus*.

<i>Name of Host</i>	<i>Number</i>	<i>Name of Host</i>	<i>Number</i>
Didelphis	11	Clethrionomys	120
Moles	45	Microtus	311
Sorex	48	Pitymys	9
Blarina	286	Ondatra	45
Bats	29	Mus	3
Procyon	3	Rattus	10
Mustela	28	Zapus	14
Mephitis	20	Napaeozapus	23
Vulpes	3	Erethizon	15
Urocyon	1	Sylvilagus	12
Tamias	23	Marmota	21
Tamiasciurus	19	Citellus	3
Sciurus	14	Neotoma	7
Glaucomys	9		
Peromyscus	217		
Synaptomys	5		
		Total	1,354

OWL PELLETS

In the course of this work all owl pellets found were collected and analyzed. Primarily this phase of the work was done to afford a check on our trapping techniques as owls often feed on species of mammals that do not appear in traps. It also affords an easy means of obtaining distributional data for the small and uncommon mammals.

A total of 33 collections of pellets were examined varying from one pellet to one large collection of over 500 pellets from a barn owl roost.

Near Mars in southern Butler County, a barn owl roost was located in an area that we had intensively trapped for over a month (Locality 1). Of the 15 species of mammals eaten our trapping in the same area had yielded all but *Cryptotis* or little short-tailed shrew. The number of individuals eaten and the percentage of total eaten is shown in the table.

The importance of this owl as a mouse catcher is readily apparent. All of the rabbits (*Sylvilagus*) eaten were small juveniles and it appears

that the barn owl can feed on rabbits only during a brief period when the young rabbits first are active as they soon are too large to be attacked by this owl. Over half of the animals eaten were meadow mice and 92% of the animals eaten were the four most abundant small mammals in that locality. The remaining 8% was divided between eleven species of mammals and several species of birds. Several species are noteworthy in that they occurred in the feeding area of these owls but did not occur in the owl pellets. Muskrats were common and were feeding in the hay meadow and grain fields where these owls hunted. Mink (*Mustela vison*) and New York weasels (*Mustela frenata*) were also common in this area.

Norway rats and very small rabbits were the largest mammals preyed upon, and then only occasionally. No remains of snakes or frogs were found.

In Beaver County, near Darlington Lake, another barn owl roost was found that had been in use for only a short time. The few pellets collected here contained the remains of 47 mammals, (see table) of which 76% were of the two most abundant mammals, the meadow mouse and the short-tailed shrew.

Twenty-one other lots of owl pellets consisting of one to several pellets were examined. Most of these were from barn owls, but there were some pellets of other small owls. Most of these were found in wooded areas which probably explains the increase in the number of deer mice (*Peromyscus*) eaten.

In addition to these, one lot of pellets that may have been produced by a hawk was found. These were all under one roost in a densely wooded area and were of interest in that they contained 27 *Microtus* and 2 *Synaptomys*, neither of which occurred in any numbers within ¼ mile of the roost, although beyond that there were numerous meadows. Red-backed mice, shrews and flying squirrels, none of which were represented in the pellets, were abundant in the woods around the roost.

SUMMARY OF ANALYSIS OF BARN OWL PELLETS

Name	Butler Co.		Beaver Co.		Other Barn Owl Pellets (21 lots)	
	No. eaten	% of total	No. eaten	% of total	No. eaten	% of total
<i>Microtus</i>	1,460	59.0	25	53.0	52	52
<i>Blarina</i>	528	21.0	11	23.0	12	12
<i>Zapus</i>	170	6.8	2	4.2	2	2
<i>Peromyscus</i>	123	4.9	3	6.4	18	18
<i>Parascalops</i>	31	1.2	0		0	0
<i>Condylura</i>	31	1.2	1	2.0	1	1
<i>Synaptomys</i>	29	1.1	1	2.0	4	4
<i>Sorex</i>	21	0.8	2	4.2	2	2
<i>Sylvilagus</i>	21	0.8	1	2.0	1	1
<i>Mus</i>	9)		0		0	
<i>Cryptotis</i>	6)		0		3	3
<i>Rattus</i>	4)	0.9	0		0	
<i>Mustela rixosa</i>	1)		0		0	
<i>Glaucomys</i>	1)		0		0	
<i>Tamias</i>	1)		0		0	
Birds (Unident.)	48	1.9	0		1	1
<i>Pitymys</i>	0		1	2.0	1	1
<i>Clethrionomys</i>	0		0		2	2
Total items	2,484		47		99	

ANALYSIS OF NINE LOTS OF PELLETS FROM ROOSTS OF GREAT HORNED OWLS

Name	No. eaten	% of total
Rabbits	29	34
Birds (Unident.)	12	14
Ducks	6	7
Muskrat	1	1
Meadow Mice	17	20
Norway Rat	10	12
Flying Squirrel	1	1
Least Weasel	1	1
Frog	6	7
Crawfish	2	2
Total items	85	

These collections are too few in number to give an accurate picture of this owl's food habits, but they do serve to emphasize the tendency and ability of this large owl to choose large prey species. The presence of only one muskrat in these pellets probably reflects the low availability of this animal in the mountainous sections where most of these pellets were found. It was noticed that crawfish were probably a more frequent item of food than indicated by the table since pellets composed entirely of crawfish disintegrate rapidly and are less likely to be found or to be recognizable as owl pellets.

CHECK LIST OF THE MAMMALS OF NORTHWESTERN PENNSYLVANIA

Didelphis virginiana virginiana Kerr—Opossum
Parascalops breweri (Bachman)—Hairy-tailed Mole
Condylura cristata cristata (Linnaeus)—Star-nosed Mole
Sorex cinereus cinereus Kerr—Masked Shrew
Sorex dispar Batchelder—Big-tailed Shrew
Sorex fumeus fumeus Miller—Smokey Shrew
Cryptotis parva parva (Say)—Little Short-tailed Shrew
Blarina brevicauda brevicauda (Say)—Short-tailed Shrew
Myotis lucifugus lucifugus (LeConte)—Little Brown Bat
Myotis keenii septentrionalis (Trouessart)—Trouessart Bat
Lasionycteris noctivagans (LeConte)—Silver-haired Bat
Pipistrellus subflavus subflavus (F. Cuvier)—Georgia Pigmy Bat
Pipistrellus subflavus obscurus Miller—New York Pigmy Bat
Eptesicus fuscus fuscus (Beauvois)—Big Brown Bat
Lasiurus borealis borealis (Muller)—Northern Red Bat
Ursus americanus americanus (Pallas)—Black Bear
Procyon lotor lotor (Linnaeus)—Eastern Raccoon
Mustela erminea cicognanii Bonaparte—Short-tailed Weasel
Mustela rixosa allegheniensis (Rhoads)—Least Weasel
Mustela frenata noveboracensis (Emmons)—Long-tailed Weasel, New York Weasel
Mustela vison mink (Peale and Beauvois)—Mink
Mephitis mephitis nigra (Peale and Beauvois)—Skunk
Vulpes fulva (Desmarest)—Red Fox
Urocyon cinereoargenteus cinereoargenteus (Schreber)—Grey Fox

Canis latrans latrans Say—Coyote
Lynx rufus rufus (Schreber)—Wild Cat
Marmota monax monax (Linnaeus)—Woodchuck, Groundhog
Citellus tridecemlineatus tridecemlineatus (Mitchell)—Thirteen-lined Ground Squirrel, Gopher
Tamias striatus fisheri Howell—Fisher Chipmunk
Tamias striatus lysteri (Richardson)—North Eastern Chipmunk
Tamiasciurus hudsonicus loquax (Bangs)—Red Squirrel
Sciurus carolinensis leucotis (Gapper)—Northern Gray Squirrel
Sciurus niger rufiventer (Geoffroy)—Fox Squirrel
Glaucomys volans volans (Linnaeus)—Flying Squirrel
Glaucomys sabrinus macrotis (Mearns)—Northern Flying Squirrel
Castor canadensis canadensis Kuhl—Canadian Beaver
Peromyscus maniculatus nubiterrae Rhoads—Cloudland Deer Mouse
Peromyscus maniculatus bairdii (Hoy and Kennicott)—Prairie Deer Mouse
Peromyscus leucopus noveboracensis (Fischer)—Deer Mouse
Neotoma magister Baird—Allegheny Wood Rat, Cliff Rat
Synaptomys coopeyi stonei (Rhoads)—Stone Lemming Mouse
Clethrionomys gapperi paludicola Douth—Red-backed Mouse
Microtus pennsylvanicus pennsylvanicus (Ord)—Meadow Mouse
Pitymys pinetorum scalopsoides (Audubon and Bachman)—Pine Mouse
Ondatra zibethica zibethica (Linnaeus)—Muskrat
Mus musculus musculus Linnaeus—House Mouse
Rattus norvegicus (Erxleben)—Norway Rat
Zapus hudsonius hudsonius (Zimmerman)—Meadow Jumping Mouse
Napaëozapus insignis insignis (Miller)—Woodland Jumping Mouse
Erethizon dorsatum dorsatum (Linnaeus)—Porcupine
Lepus americanus virginianus (Harlan)—Varying Hare, Snowshoe Hare
Sylvilagus floridanus mearnsii (Allen)—Cottontail
Odocoileus virginianus borealis (Miller)—Northern White-tailed Deer

In addition to the above forms that are known to occur in northwest Pennsylvania, the following should be mentioned:

Sorex palustris albibarbis (Cope)—Water Shrew
Lasiurus cinereus (Beauvois)—Hoary Bat
Lutra canadensis canadensis (Schreber)—Otter
Rattus rattus rattus (Linnaeus)—Black Rat

Although the water shrew was not taken, it should occur in the high plateau section of McKean or Elk Counties since it has been taken in New York State in Alleghany State Park just north of McKean County, (Eaton 1945) and just east of this section, in Potter County, Pa., (Wible 1946).

Whether or not the hoary bat spends the summer in this section is not known but since this bat is a migratory species, it should occur in this section during the spring and fall. No specimens were taken.

The otter is recently extinct throughout most of this area. There are occasional rumors of otters along the wilder portions of the Clarion River, but we were unable to verify any of these.

Although no specimens of the black rat were obtained, it was reported by James Kosinsky to have been common near DeYoung in northwest Elk County as late as 1940.

CONCLUSIONS and RECOMMENDATIONS

Although much of the information obtained from this type of survey is of greatest value as reference material for those who are dealing with specific wildlife problems in this area, either now or in the future, certain of the information obtained suggests specific recommendations:

1. The glaciated section of northwest Pennsylvania is dotted with innumerable small swales and marshy stream margins that could be made very productive of game and fur if they were not drained and/or pastured. Proper utilization of these individually small areas seems to be largely a matter of educating interested landowners to apply practices of good stream management.
2. In the generally forested area of the high plateau section from McKean County to northern Jefferson County we noted the extensive utilization of the vegetation on road shoulders during April and early May when the vegetation in the woods was still dormant and that along the road shoulders was green. The availability of early forage along the roads of this section is due, only in part, to greater exposure to sunlight. Of greater importance is the addition of lime from road ballast and paving materials which produces a soil suitable for clovers and blue grass in an area where the soils are generally acid.

During early spring the following species were observed feeding along the road: deer, snowshoe rabbits, cottontail rabbits, groundhogs, porcupines and grouse. After the middle of May only two forms, groundhogs and cottontails, were seen to feed regularly on the roadside.

These observations suggest that liming of the extensive power line and other right-of-ways that traverse the forests of those counties would be a most inexpensive management practice, both in terms of immediate cost and in the amount and distribution of forage produced.

3. The present all time high fox population in eastern United States appears to offer a rare opportunity to evaluate the Pennsylvania fox bounty program by a study of the expenditures for fox removal and the costs of all phases of fox damage in this state as compared to similar costs in surrounding states that have had no bounty program.

We are also offering three other recommendations that are not the result of our studies, but which represent information which we believe is needed to interpret and understand properly wildlife fluctuations in this state:

1. One of the problems in dealing with diseases in wildlife has always been the early discovery of outbreaks and the obtaining of specimens of diseased animals in time to permit examination and diagnosis. In this respect Pennsylvania is fortunate for many of its sportsmen, trappers and landowners are interested in wildlife to the extent that they will report unusual conditions, save specimens, and will take the time to refrigerate or otherwise care for such material. To utilize best this interest, and to encourage

further such cooperation, as well as to obtain much needed information on wildlife diseases, there is need for the services of a wildlife pathologist.

2. That a program be set up for obtaining estimates of the condition of the mast crop in each district or county. It should be sufficiently detailed to include estimates of four or five principal food producing trees. Since the amount of mast is an important factor in the over winter loss of forest game, particularly squirrels and turkeys, such information would be of value in fixing seasons and bag limits for the following season, as well as be useful in interpreting game kill records from the various sections.
3. That a method be developed for obtaining accurate fur take records for the state, by counties. The need for this is based on the fact that all but two of the fur-bearers in this state are carnivorous, and it is important to regulate the take of these animals in such a manner as to protect them when they are scarce, and to reduce their numbers in times of abundance. Such information would go far toward answering such questions as:

How much is the annual take of foxes and weasels influenced by bounty payments, size of bounty payments and prevailing fur prices?

It would afford a means of more accurately measuring the effect of reducing or increasing the trapping seasons. On a county or district basis, it would, in time, give a figure of how many animals of each fur-bearer should be harvested annually. It should serve to indicate areas in which predators were increasing or decreasing. (At present the bounty records show this for the foxes and weasels, but do not show it for mink, raccoon, opossum, skunk, wildcat and otter.) Together with the present records of big game kill, small game estimates, beaver kill and bounty records, it would permit a regional approach to the study and regulation of the annual harvest of one of our important wildlife resources.

DATA and REPORTS

The original data, field notes, and specimens upon which this report is based have been deposited in the Section of Mammals, Carnegie Museum, Pittsburgh, Pennsylvania.

This report was prepared by Neil D. Richmond, Project Leader, and Harold R. Roslund, Assistant Project Leader.

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